May

25 cents

Science and Invention

FORMERLY
ELECTRICAL EXPERIMENTER

THE AUTOMOBILE OF 1973

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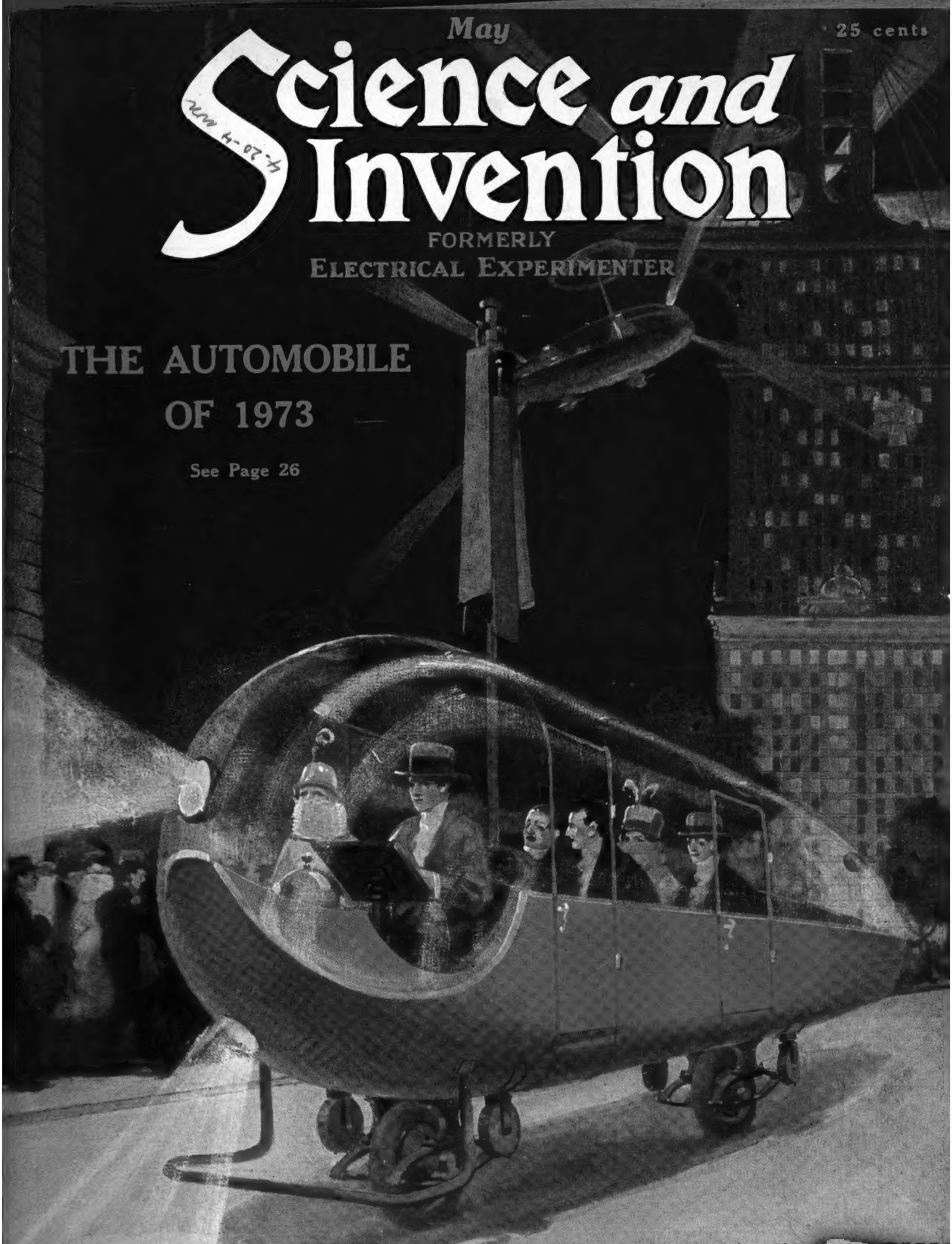

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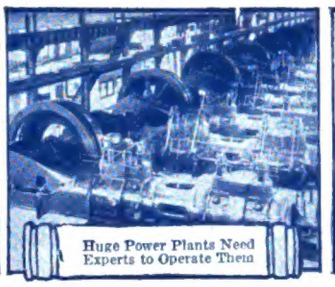

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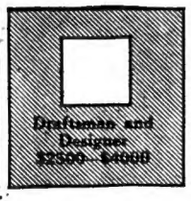

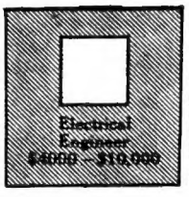

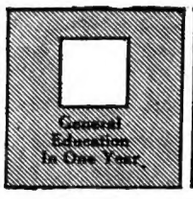

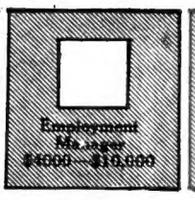

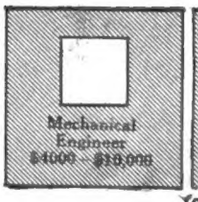

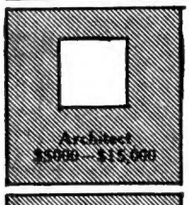

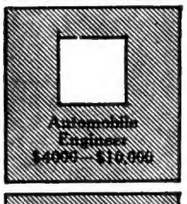

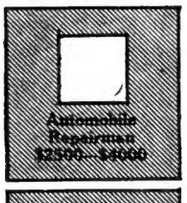

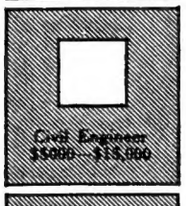

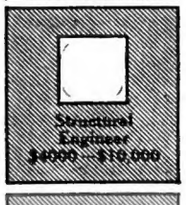

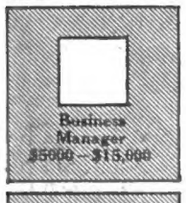

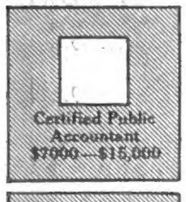

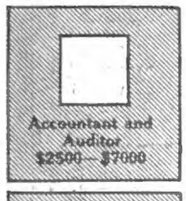

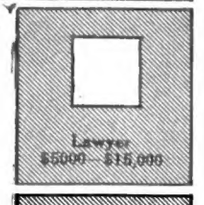

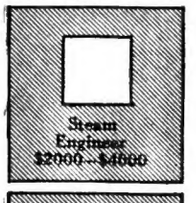

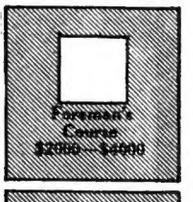

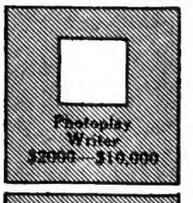

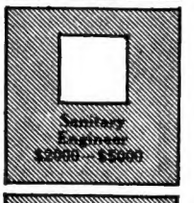

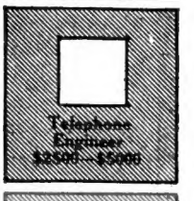

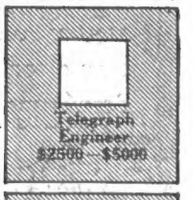

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FORMERLY

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Electrical Shop, Honolulu, Hawaii.
Electric Appliance Co., San Francisco, Calif.
Finch & Hahn, Schenectady, N. Y.
Foster Book & Cigar Co., St. Louis, Mo.
Foster Radio & Elec. Co., Wilkes-Barre, Pa.
Findley Electric Co., Minneapolis, Minn.
Flecks Electric Service Sta., Tiffin, Ohio.
Electric Co., (Grenda & Sether) Fergus Falls, Minn.
Gee Electric Co., Wheeling, W. Va.
Galveston Wireless Supply Co., Galveston, Texas.
Goetz's Music Store, Fort Worth, Texas.
Huse & Sons, W. A., Providence, R. I.
Hunter, J. B., Boston, Mass.
Hubbard Elec. Co., Battle Creek, Mich.
Hygrade Elec. & Nov. Co., New York, N. Y.
Hynson Electric Co., Portland, Oregon.
Hill Co., Geo. A., Lowell, Mass.
Hentzschel, W. W., Baltimore, Md.
Heinemann Electric Co., Philadelphia, Pa.
Hamilton, H., Greensburg, Pa.
Interstate Elec. Co. of Ala., Birmingham, Ala.
International Radio Corp., Winnipeg, Man. Can.
International Electric Co., Wellington, New Zealand
Jacksons Radio Eng. Lab, Waco, Texas.
Knoxville Radio Co., Knoxville, Tenn.
King, H. W., Des Moines, Iowa.
Koch, John R., Charleston, W. Va.
Law, E. M., Norristown, Pa.
Laws Blythe Electric Co., Atchison, Kansas.
Linze Elec. Supply Co., St. Louis, Mo.
Modell's, New York City.
Mechanics Co., H. C., Fort Worth, Texas.
Murray Spring Co., W. A., Cincinnati, Ohio.
Macaulay Bros., Detroit, Mich.
McArthur Electric Co., Chicago, Ill.
Natick Book Store, Los Angeles, Calif.
Northwest Radio Service, Seattle, Wash.
Noll & Co., E. P., Philadelphia, Pa.
Nelsons Radio Supply Co., Phoenix, Ariz.
National Auto Supply Co., Terre Haute, Ind.
Public Library, Detroit, Mich.
Phila. Wireless Sales Corp., Philadelphia, Pa.
Perrault, F. J., Natchez, Miss.
Polozynski & Co., B. E., Detroit, Mich.
Peerless Electric Co., Minneapolis, Minn.
Phila. Sporting Goods Co., San Francisco, Calif.
Roberts Bros. Electric Co., Philadelphia, Pa.
Radio Eqp. Co. of Texas, Dallas, Texas.
Radio Concert & Eqp. Co., Los Angeles, Calif.
Radio Electric Shop, Cleveland, Ohio.
Reutter Electric Co., Cincinnati, Ohio.
Reynolds Radio Co., Denver, Colo.
Randolph, J. O., Higbee, Mo.
Radio Electric Co., Fort Worth, Texas.
Radio Chain Stores, Trenton, N. J.
Radio Specialty Co., New York City.
Self Service Phonograph Co., New York City.
Skokos, S., Perth Amboy, N. J.
Spectator, The, Bruce Mines, Ont., Can.
Snell Co., Geo. W., Philadelphia, Pa.
Schroeder Electric Co., Albany, N. Y.
Smith, H. E., Batavia, N. Y.
Southern Elec. Co., Jacksonville, Fla.
S. A. S. Radio Co., Paterson, N. J
Steiger & Co, E., New York City.
Sykes & Co., Rochester, N. Y.
Security Radio & Supply Co., St. Louis, Mo.
Superior Radio & Eqp. Co., Columbus, Ohio.
Steward Elec. Service Co., Urbana, Ohio.
Utzinger Book Store, Astoria, Oregon.
Universal Supply Co., St. Louis, Mo.
Veihl Crawford Hdw. Co., Fort Worth, Texas.
Vulcanizers Supply Co., Kansas City, Mo.
Virginia Radio Service, Medford, Ore.
Viking Radio Co., New York City.
Wile, Eugene G., Philadelphia, Pa.
Woodhead, L. F., Rosewell, N. M.
Williams Book Store, Boston, Mass.
Wilbur Electric Co., Baltimore, Md.
[illegible]son Electric Co., Seattle, Wash.
[illegible] L., New York City.
[illegible] B., (Archway Book Store) Seattle, Wash.
Nashville, Tenn.

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LOUD-TALKERS
HOW TO BUILD THEM

By H. WINFIELD SECOR

Associate Editor of Science & Invention

This book describes how to build two distinct and different types of radio loud-talkers, which can be built with either electro-magnetic field to be excited from storage battery, as well as permanent magnet field requiring no separate battery excitation. The third chapter deals with improvised loud-talkers and gives clear and complete instructions on how to build suitable horns for use with radio receivers of the Baldwin and other types. Several elaborate hook-ups are given of the author's own radio receiving set, comprising one stage of radio-frequency, detector and three stages of audio-frequency amplification, together with all the connections for the loud-talker.

Complete data is given for all the parts of the loud-talkers, including the field magnet windings, as well as the diaphragm or moving coil windings, and also the step-down transformer to be connected between the vacuum tube amplifier and the loud-talker proper.

In preparing these designs the point has been constantly kept in mind to use the simplest parts possible, so that practically anyone can build a successful loud-talker equivalent to the commercial types costing $40.00 or more.

Even where the experimenter does not possess the skill or the time to make all the parts himself, which are really few in number, he may save a great deal of money, or at least half the price of a commercial loud-talker, by having the difficult parts made in a local machine shop, and then assembling them and winding the coils himself. Circuit connections and data for the size of wire, etc., are given for placing the loud-talker on a separate floor or in another part of the house not occupied by the radio receiving set. A very valuable book, giving data which cannot be obtained anywhere else and which has not been published before.

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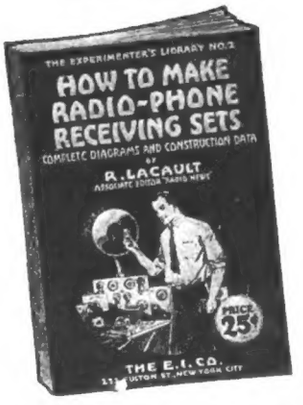

A non-technical book for the beginner. Gives complete constructional data on the building of a complete Crystal Detector Set, Tuning Coil, Loose Coupler and a Single Audion Tube Set with Amplifying Units. It furnishes all dimensions and working drawings of every part that must be constructed by the amateur. Written in plain, simple language that anyone can understand. The opening chapter gives a complete description of the theory of radio and tells what it's all about, teaching the principles of wireless so that the constructor knows what he is doing.

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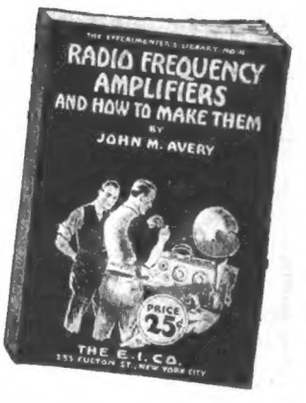

This book is for the more advanced amateur, showing the construction of the Radio Frequency Amplifying Transformer and giving complete constructional data. It shows the application of Radio Frequency to amplifying units that the amateur may already possess and gives 15 hook-ups showing practically every use Radio Frequency Amplifying Transformers can be put to.

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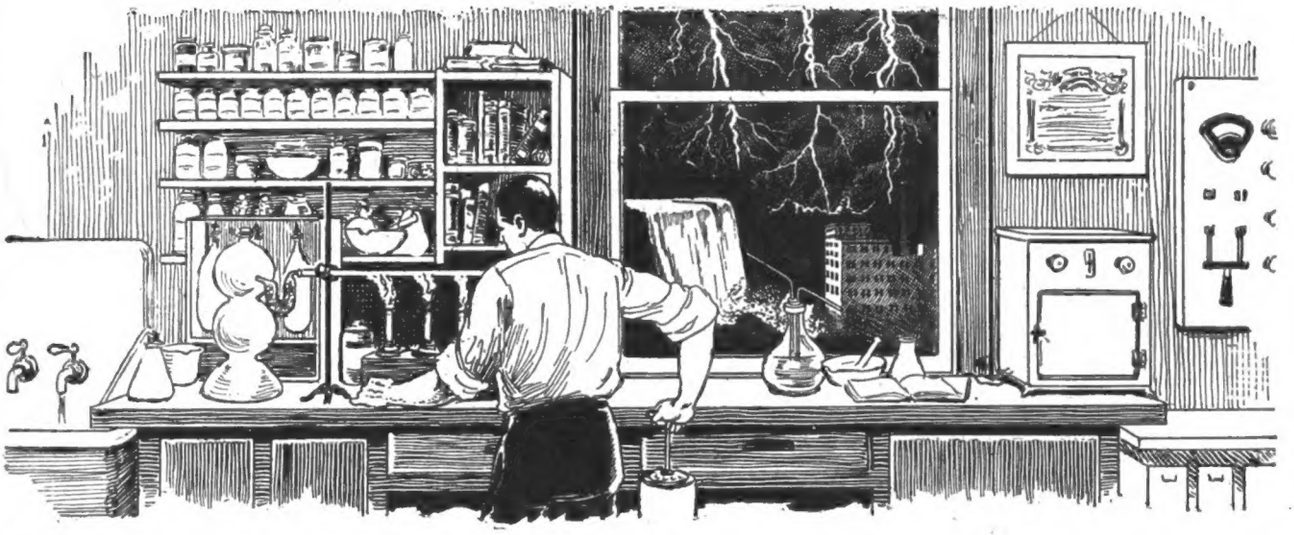
When the Chemist Harnessed the Thunder-bolt!



MAN and beast react with electric speed to a warning of danger, if the alarm is immediate and personal. Self-preservation is the first law of Nature. Yet subtle perils far more disastrous than any we expect to meet lurk in the shadow of our fancied security. They are the dreaded ogres of Famine and Disease.

A few years ago the world faced a famine more terrible than any in history. Nitrates, the most essential materials for enriching the soil, were being rapidly exhausted, and universal starvation seemed inevitable. Everyone knows that plants must feed, and if the ground is not replenished with the chemicals they have consumed, vegetation will eventually die out. Nature's way of making up the deficit is too slow for our concentrated population, and farmers have resorted to artificial fertilizers for ages. Europeans, always more receptive to the teachings of Chemistry than we, raise more than twice as much grain per acre as Americans, owing to their greater use of fertilizing chemicals.

The principal substance used for this purpose is sodium nitrate, better known as Chile saltpetre, because of the large deposits of it in that country. Millions of tons of this precious chemical were being mined annually, for vast quantities are consumed in making explosives and in other industries, besides that required for agriculture. Chile kept getting richer, but her nitrate beds got continually poorer until their inevitable exhaustion became a grisly prospect. *And there was no other source of supply!*

It was here that electro-chemists stepped in and devised a way of making nitrates from the air! They stole a trick from Nature, using an artificial bolt of lightning, the electric arc, to change the nitrogen and oxygen into nitric acid. This is indeed what happens during a thunder-storm, though to a very slight extent. Other methods followed, and thanks to Chemistry the air-made nitrates can now be sold for less than the saltpetre of Chile. Better still, the supply is unlimited.

Today we are confronted with similar crises. There are impending shortages of other important raw materials. Yet so great is the general confidence in chemistry to solve such problems, little anxiety is felt. A wealth of opportunity awaits the chemist of the present, particularly in the fascinating field of Electro-chemistry. In many industries there are hundreds of chemists employed by a single company. Thousands of concerns have chemists supervising the quality of their output and of the materials they buy. In countless capacities a knowledge of Chemistry is essential.

You Can Learn Chemistry at Home Dr. T. O'Conor Sloane Will Teach You

Dr. Sloane, Educational Director of the Chemical Institute of New York, is one of this country's foremost authorities on chemistry. He was formerly Treasurer of the American Chemical Society and is a practical chemist with many well-known achievements to his credit. Not only has Dr. Sloane taught chemistry for years, but he was for a long while engaged in commercial chemistry work.

The Chemical Institute of New York was originally founded to fill a long-felt need in the Educational field. Thousands of young men and young women, realizing the wonderful opportunities for the chemist produced by the recent war and the assumption by the United States of world leadership, were keenly anxious to enter this promising field. Many of these prospective students, however, were unable to give up their regular occupations to devote the necessary time to their training. Correspondence study at home was the only solution.

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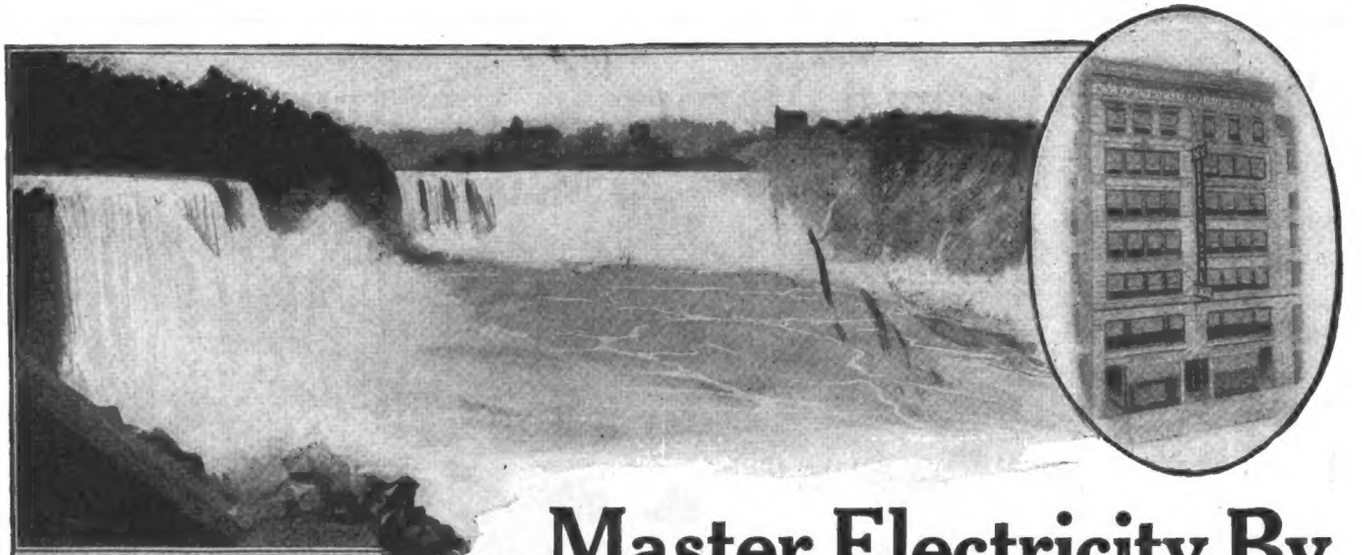

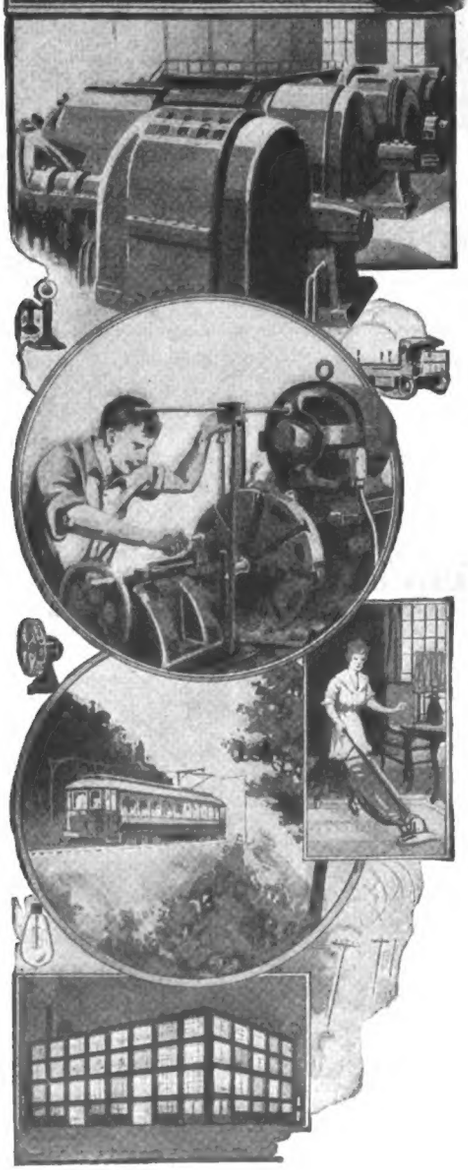

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Volume XI
Whole No. 121

Science and Invention

H. GERNSBACK, EDITOR AND PUBLISHER
H. WINFIELD SECOR, ASSOCIATE EDITOR
T. O'CONOR SLOANE, Ph.D., ASSOCIATE EDITOR
Editorial and General Offices, - - - 53 Park Place, New York

MAY
1923
No. 1

"Those Who Refuse to Go Beyond Fact Rarely Get As Far As Fact"--HUXLEY

The Future of Broadcasting

THE layman, upon being first introduced to present-day Radio, invariably expresses astonishment that the service costs him nothing. People have become so used to paying for service, that they can not comprehend why our various broadcasting stations should render such a wonderful service as they are doing now, free of charge. The modern broadcasting station costs anywhere from $10,000 upwards, for the installation, and this will not be a first-class station. A high-powered modern broadcasting installation costs as much as $50,000, in its first investment. Then there is the personnel, advertising, and other expenses, that run up to anywhere from $10,000 to $50,000 a year for each and every station.

Many people who have not known the inside of the story have been unwilling to invest money in home outfits, because they thought that broadcasting could not possibly last. These people, and there are a good many of them, seem to have an idea that most of the broadcasting stations are only for temporary use, and that sooner or later they will be forced to go out of business.

Many letters come to the editor's desk in the course of a day, that express just such apprehensions. The usual question is "Will broadcasting last?"

The answer is that there are some 600 stations in this country now, a good many of them over a year old, and a fair percentage which are already three years in existence. These stations have constantly increased their power and improved their programs until they have now become a national institution.

Of course, some of the stations are operated simply as an advertisement for the firm that is doing the broadcasting. Thus, for instance, large newspapers and big department stores think the advertisement and publicity is well worth the money. Naturally these stations do not broadcast, and offer no wares for sales. One of the largest eastern broadcasting stations, owned by a large department store, never once in its history has mentioned the name of any product which it had for sale. All the advertisement that the store gets out of the station lies in the few words of the announcer, saying that Station So-and-So, operated by Such-and-Such a Department Store, is broadcasting This-or-That Opera tonight.

It is assumed that the several hundred thousand listeners who hear the name of this department store mentioned, constitute a foundation for good advertising. On the other hand, our large electrical corporations, which operate broadcasting stations and derive but little benefit from the mentioning of their name, derive their principal profit from the sale of radio receiving apparatus, of which they either control the patents or are otherwise interested in. Such corporations find broadcasting stations are an indirect means of doing business, and they could not sell as many outfits, radio parts and supplies if these stations were not going all of the time. In other words, a broadcasting station creates a huge market for radio instruments. There will, however, come a time, when the business manager of the firm who is doing the broadcasting will wish to see some real money.

To be sure, not all advertising is direct. Much of it is indirect in its results, but in the case of a broadcasting station which performs a service, such service should be paid for by those whom it benefits.

It is obviously not possible for the broadcasting station to ask the public to pay for the service, because no one knows how many receiving stations there are, nor where they are located. Nor would it be desirable to have such a state of affairs.

There are, however, other means to accomplish the same purpose. For instance, recently a German opera company, which has been giving operas at the Manhattan Opera House, permitted one of the large broadcasting stations to broadcast an entire opera. This was a creditable undertaking, and hundreds of thousands of radio fans listened with great satisfaction to this opera. Previous to this the opera company was playing to almost empty houses. The very next day, however, the Manhattan Opera House was stormed by the very radio fans who had listened in the night before! The *New York Times* commented upon this in an article, and actual investigation proved that the unusual attendance was directly traceable to this broadcasted opera.

The writer believes that in the future, opera, as well as musical comedies, dramas, etc., will be broadcast on a large scale *and that the producers will pay broadcasting stations handsomely* to thus broadcast one or more acts of their productions. This is legitimate and is indirect advertising, but the direct results from such broadcasting are certain to be of an inestimable value to our producers. The writer considers this form of broadcasting to be unobjectionable. On the other hand, all direct advertising, such as mentioning the names of wares, even vaguely, should never be done, as it is certain to prove a boomerang sooner or later for the broadcasting stations.

H. GERNSBACK.

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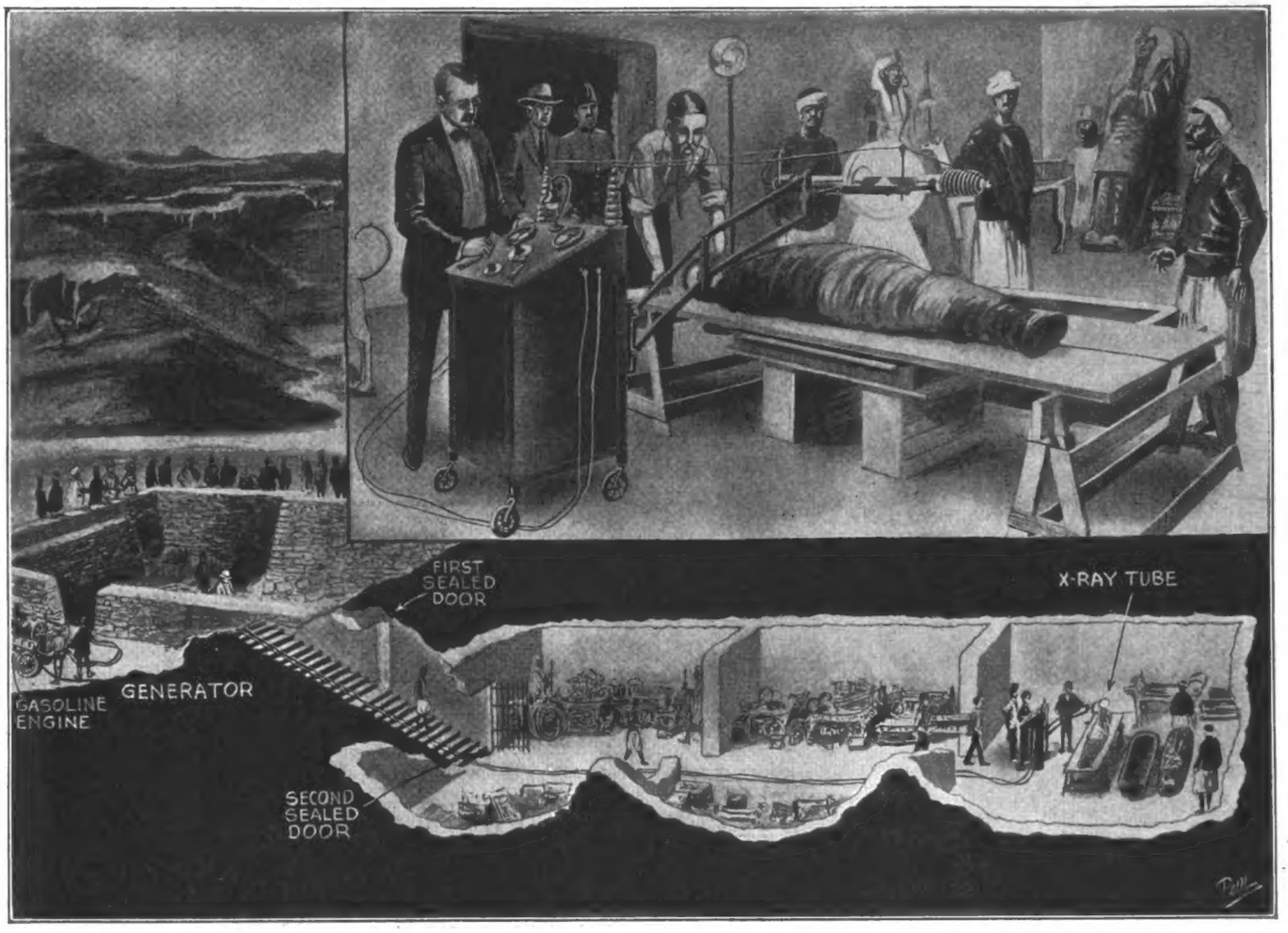

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It Has Been Proposed That at Some Later Date When the Inner Chamber of Tut-ankh-Amen's Tomb is Opened and His Mummified Body Exhumed, That X-Ray Photographs of His Body Be Made in Order to Learn as Much as Possible About Its State of Preservation. There Was Considerable Doubt in the Editors' Minds as to Whether the Bones of a Mummy Would Show in an X-Ray Photo. In Order to Determine What Might be Expected in X-Raying Tut-ankh-Amen's Body, Special Arrangements Were Made with the Museum of Natural History, at Which Place We Were Able to Take Large X-Ray Pictures of a Peruvian Mummy About Four Hundred Years Old, the Results of Which Are Shown in the Large X-Ray Skeleton Picture on the Opposite Page. The Illustration Herewith Shows How the X-Ray Apparatus, Supplied by Current from the Dynamo Driven by a Gasoline Engine on a Truck or Otherwise, Will No Doubt Be Employed by Lord Carnarvon and His Experts.

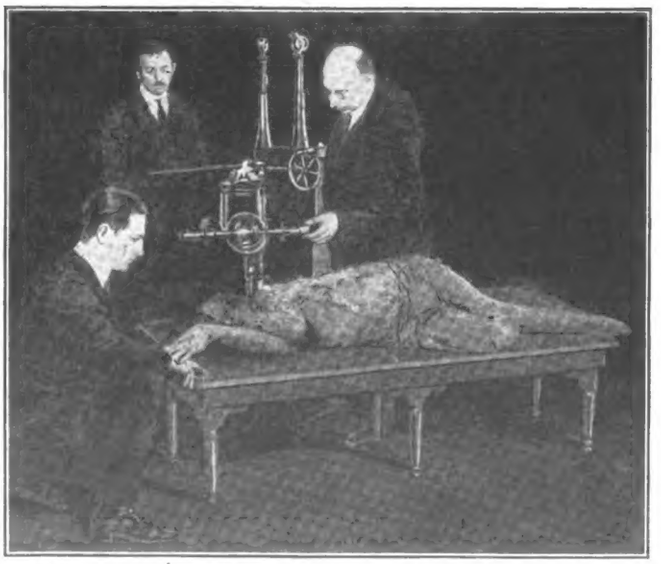
First X-Rays of Mummies

By JOSEPH H. KRAUS

STAFF MEDICAL EXPERT

Do you know why Egyptians preserved the bodies of their dead? Do you know how these were preserved? Do you know the uses to which chemistry is put in modern times to continue to preserve these objects? Do you know the type of religious rituals in vogue at the time of King Tut-ankh-Amen? Do you know that the X-ray can be used in many ways to assist us in the study of the ancients? These and many other questions are answered in the following article.

THE discovery in the Valley of the Kings, near Luxor, Egypt, of the royal Tut-ankh-Amen, caused quite a furore in scientific circles. Other important discoveries were given but a small space in the back columns of the newspapers, while King "Tut," as the headline writers [illegible] him, occupied the first [illegible] not for the extreme dryness of the climate and the almost airtight character of the subterranean chambers where these treasures described by the newspapers were found, they would have crumbled to dust long ago.



The Photograph Above Shows the Author of the Article and Dr. Charles W. Mead, Curator of the Peruvian Department of the Museum of Natural History, New York City, Who Kindly Cooperated with the Editors in Making the Very Interesting and Original X-Ray Skiagraphs of a Mummy Four Hundred Years Old, This Mummy Being That of a Peruvian Indian.

The discovery of the royal tomb was made by George Edward Stanhope Molyneaux Herbert, fifth Earl of Carnarvon, popularly known as Lord Carnarvon, although the actual work was done by an American named Carter.

X-RAYING THE MUMMY

Some mummies fall to dust the moment they are touched, or at the very instant the sarcophagi are opened. In others, it is impossible to differentiate between bitumen and the bones.

It has been suggested that Lord Carnarvon use an X-ray on the sarcophagus before attempting to open it to determine whether or not there is a body contained therein, and if so, whether it would be safe to open the

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sarcophagus. We have been told that it would be impossible to take X-ray photographs of a mummy because the bones would be just as transparent to the rays as the tissues of the body. Accordingly, we prevailed upon the Museum of Natural History of New York to loan us a mummy for the sake of experiments. Not only having received their consent but their earnest cooperation in this experiment, and particularly that of Dr. Charles W. Mead, the curator of the Peruvian Department, we asked the Kny-Scheerer Company of America to supply us with one of their X-ray machines. Being interested in the experiment, their X-ray technicians were present for the momentous occasion. While newspapermen stood around and moving picture cameras clicked, we proceeded to diligently X-ray a mummy, section by section, as our photograph clearly indicates. The photographed sections were then matched, one fitting against the other, and a complete photograph was obtained. This photograph is reproduced here and shows to what extent our results were satisfactory.

A bedside unit was the type of X-ray apparatus employed. A completely shielded tube of the Coolidge type with the heated element having an extremely high penetrative value, was used. The voltage delivered by this machine was above 300,000 volts. The only difference in taking these pictures was that the exposure had to be increased fourfold. The reader will notice how the fractured rib stands out boldly in this photograph. This is the first time an X-ray photograph of a complete mummy has been taken.

The proposed plan to be adopted by Lord Carnarvon is graphically shown in the illusration at the head of this article. Here we see the actual location of the first and second chambers, as well as the location of the third chamber where the sarcophagus of the King is expected to be found. In the tomb of Seti II, the chemical laboratory is located. This is not indicated in the diagram. Outside of King Tut-ankh-Amen's post mortem abode, we see the gasoline engine on a truck driving a generator. The cables from the generator pass down the stairs through the first and second chambers, where they supply current not only for the lights of the motion picture photographer, but for the X-ray apparatus. Having examined the sarcophagus by means of a fluoroscope to determine whether or not it would be safe to disturb the body, it is moved from its position while the dust of centuries falls from its sides. With great care it is placed across some adequate support and the X-ray pictures are taken in full size. It is quite evident that theft of the mummy could be easily detected, and identification of the King becomes possible by means of the X-ray as no two mummies are exactly alike; the bone markings heretofore claimed to be undetectable and found to be positive and sharp in our research, would also assist in the identification.

New types of lamps were shipped to Luxor, so that the shades and colorings of the precious stones and the texture of materials may be the more readily seen. The light gives a diffusion similar to daylight and of a color identical with that obtained from a north sky window. The claim made by some scientists that the bodies of the Egyptians were mummified, not due to the method of embalming, but due rather to the dry climate which is found in Egypt, is in the writer's opinion, incorrect. If this were the case then every mummy from the first dynasty to about four

(*Continued on page 64*)

No, This is Not King "Tut," But the Nearest We Could Come To It in Making an X-Ray of a Mummy, as Lord Carnarvon Proposes to Do with Tut-Ankh-Amen's Mummified Body When it is Removed from the Inner Tomb, Possibly Six Months to a Year from Now. This Composite X-Ray Picture is the First Complete Skiagraph of a Mummy, So Far as the Editors Are Aware, and Required a Whole Day's Work by a Corps of X-Ray Experts, with the Cooperation and Assistance of Dr. Charles W. Mead, of the Museum of Natural History, New York City. The X-Raying Was Carried Out by the Author with the Cooperation of Dr. Mead and Mr. Stoye of the Kny-Scheerer Company, Who Furnished the Powerful X-Ray Machine and High-Power Coolidge Tube Necessary in Taking These X-Ray Pictures. The Skiagraph Shows Clearly the Fractured Rib of the Peruvian Indian. The Size of the Mummy Corresponds to That of the Average Man of Today.

This Mummy is About Four Hundred Years Old, and While the Editors Were Very Doubtful Whether the Bones Could Be Differentiated from the Mummified Flesh and Muscle Tissue, the Results Clearly Show That Very Excellent X-Ray Pictures Can Be Taken of King Tut-ankh-Amen. The Main Difficulty in Taking These X-Ray Pictures of the Mummy in the Museum, as Compared with Taking Such Pictures of the Live Subject, Was That the Exposure or Time During Which the X-Rays Were Permitted to Pass Through the Body on to the Photographic Plate, Had to be Increased Fourfold.

It Was Hoped That Some of the Internal Organs Might Show Up on the X-Ray Plates, But as This is Seldom the Case with Live Subjects, Unless They Have Been Given a Bismuth Meal, This Did Not Occur.

The Three White Lines on Either Ankle Indicate Straw Anklets Found on the Mummy, and the Only Clothes Consists of a Cloth Girdle About the Loins. The Peculiar Position of the Body Was That in Which the Mummy Was Found in a Copper Mine in Peru, and it is Thought that the Copper Sulphate Present Had a Great Deal to do with the Preservation of the Body. This Also Made the Mummy Much More Difficult to X-Ray Than That of Tut-ankh-Amen, Owing to the Copper Deposits and Infiltration Present.

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An Under-Sea Pleasure Trip

"RIGHT this way. The famous ride into Neptune's domain. ride through and under the sea. Only twenty cents, a fifth part of a dollar." This cry greeted us as we were passing along a road skirting the beach at one of the favorite summer resorts. Our attention was attracted by the crier's call to a large sign, "Ride Through the Sea Below the Level of the Waves," and surrounding this colored posters could be seen showing sea serpents, fish and corals in artistic combinations. Here on another poster we found a wreck of some old frigate. It lay as a skeleton, its ribs extending upwardly from its sandy grave; an octopus had entwined one of its tentacles around one of the ribs. A fantastic picture of the Sea Sled, the conveyance which was daily taking passengers into the kingdom below the level of the sea, was also shown.

Having purchased our tickets we passed down to the end of the pier, where a large raft already crowded with expectant visitors was awaiting the arrival of the next sub-sea sled. Soon a speedy tug boat hove in sight. As it reached the shallow water, we saw emerging from the depths a large body coming up like the nose of a whale and elongated itself as it emerged from beneath the waters. It was towed alongside of the raft, a water-tight door opened, and an elated group of passengers left the submarine, a sort of car body carried on sled-like runners.

Many passengers remained for a second ride, and it was not until two or three subsequent trips had been made, that we finally found room to enter the water-tight compartment. Once inside we positioned ourselves close to the operator, so that we could the more readily understand the various constructional details of this Sea Sled.

The submarine-like body was mounted on sled runners, and the sled was fitted with elevating rudders as well as horizontal rudders. It was devoid of any power, but was towed along the bottom of the sea by a tug or motor boat; two towlines passed from the tug boat to the sled. The operator in the sub-sea vessel kept his eye on the tug boat on the surface, and directed the sled as he would an automobile towed by another. Whenever a rock or other projection rose from the bottom of the sea, he simply drew his steering wheel toward him, causing the elevating rudder to be raised, whereupon the sea sled left the bottom. In doing so, the passengers experienced a delightful rocking sensation.

Ballast tanks were located near the bottom of the sled, and an air hose leading to compressed air tanks located in accessible positions between the runners, served to blow out these ballast tanks in case of accident. The amount of water in the tanks was automatically controlled by the weight of the passengers within the sled. This automatic control permitted the sled to be towed along the ocean's bottom very easily, the friction being practically eliminated, due to the very slight amount of negative buoyancy which the sled possessed. This negative buoyancy was further reduced by the action of the elevating rudder in the

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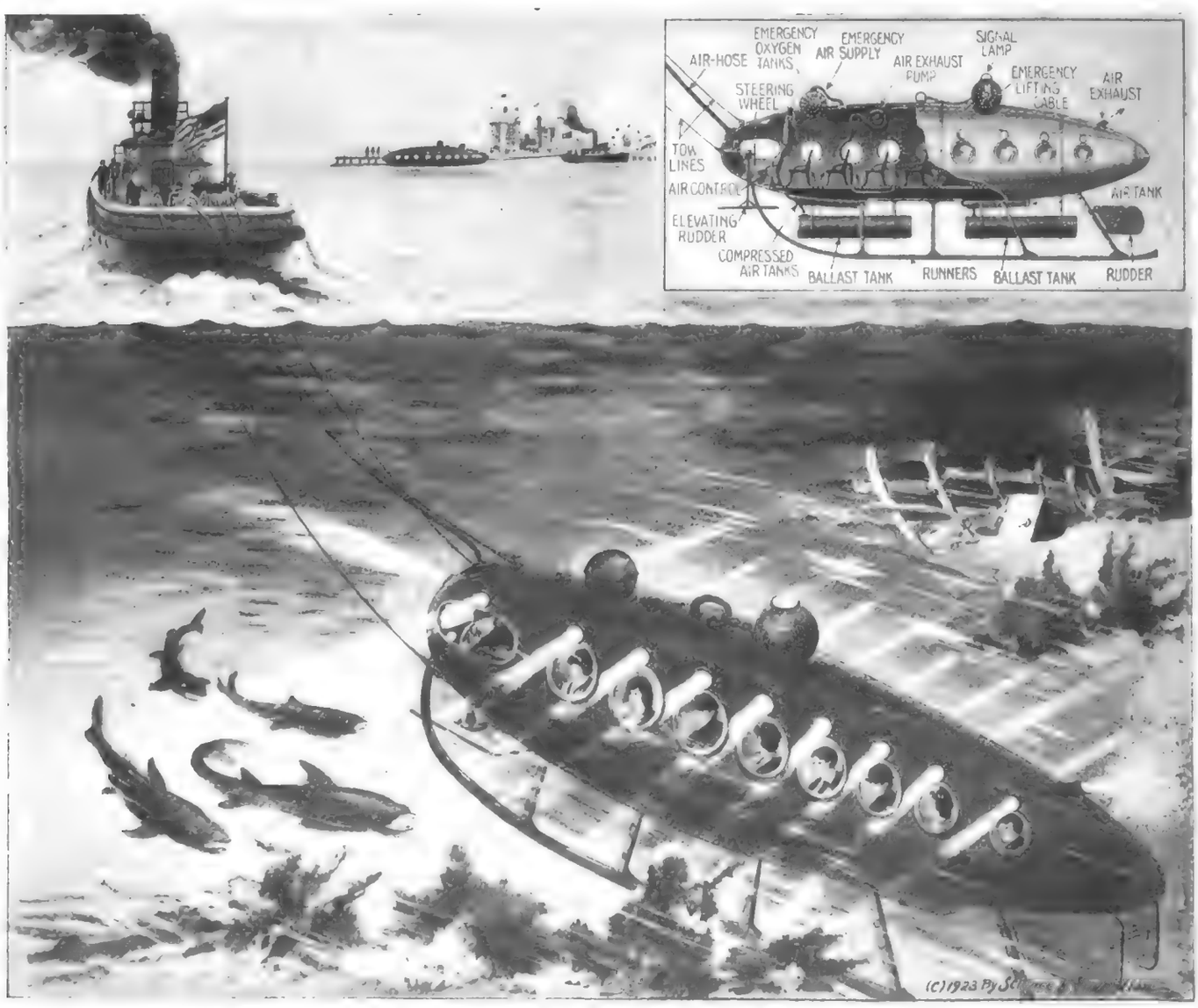

The "Sea Sled" Shown in the Illustration Above is the Latest Idea in Amusements for Sea-Side Summer Resorts. It Gives the Spectators the Greatest Thrill Possible Without the Slightest Element of Danger.

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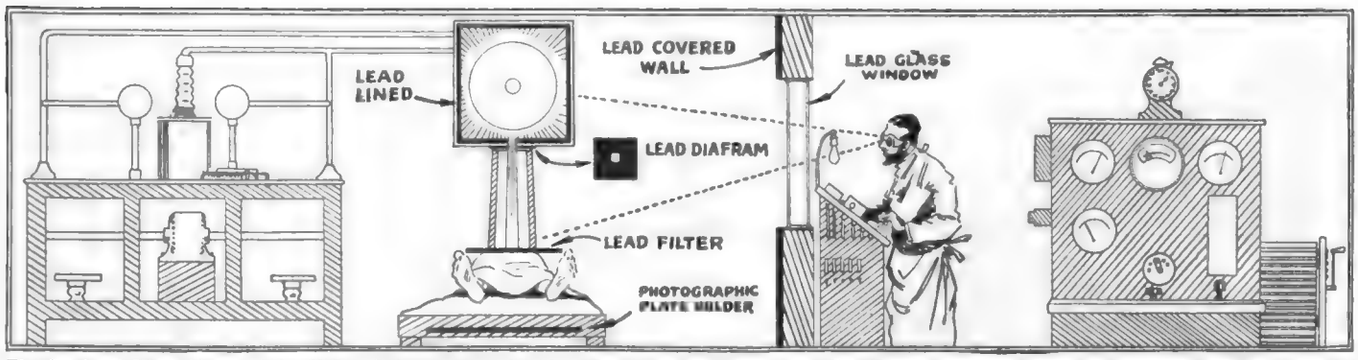

The Sectional View Above of the X-Ray Laboratory at the Montefiore Hospital, New York City, Shows How the Doctor is Protected from the Powerful X-Rays by Means of a Thick Lead Glass Window, Through Which He Can Watch the Machine and the Patient as Well. A Lead Filter and Lead Focusing Diaphragm Are Interposed Between the Patient and the Giant X-Ray Tube, Which Latter is Also Enclosed in a Lead Lined Cabinet. The Beam of X-Rays Applied to the Patient at the Desired Spot, Pass Through the Opening in the Lead Diaphragm, Thence Through the Lead Filter Placed Directly Over the Patient, Through the Body and in Turn Affect the Photographic Plate Placed Under the Couch on Which the Patient Lies.

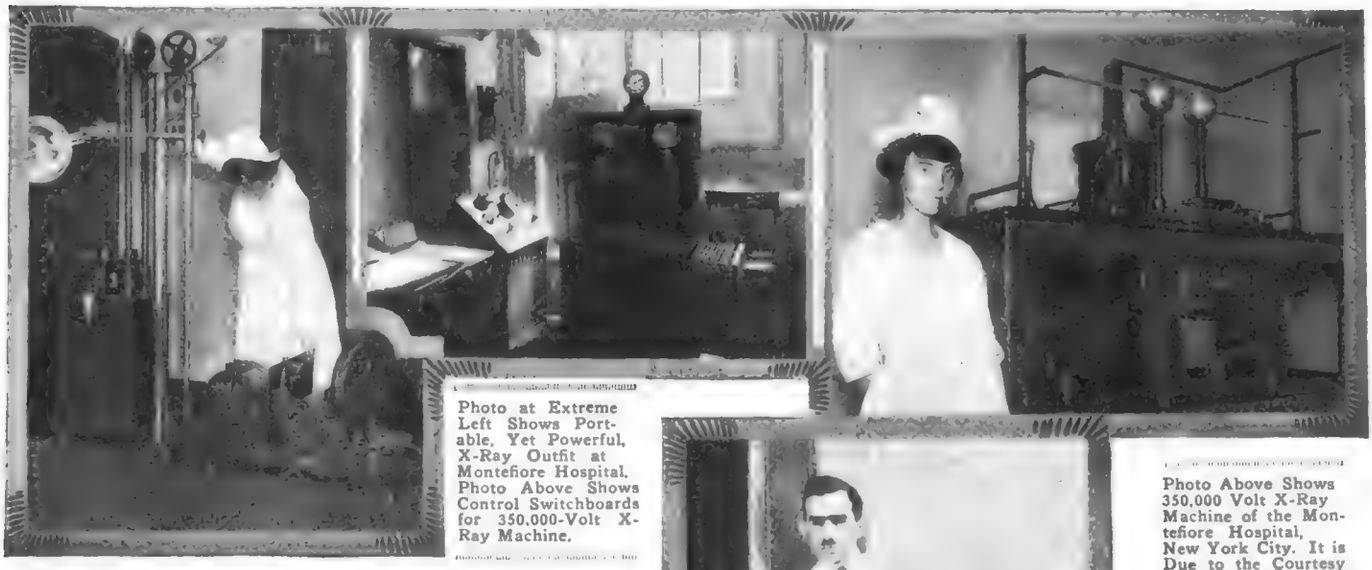

Photo at Extreme Left Shows Portable, Yet Powerful, X-Ray Outfit at Montefiore Hospital. Photo Above Shows Control Switchboards for 350,000-Volt X-Ray Machine.

Photo Above Shows 350,000 Volt X-Ray Machine of the Montefiore Hospital, New York City. It is Due to the Courtesy of the Staff of That Hospital, and Especially Dr. Isaac Levin, Chief of the Cancer Division of This Hospital, That We Are Able to Give the Information Herewith Presented. The Ultra-Powerful X-Ray Tube of the Coolidge Type Used With This Tremendous Voltage is Shown at Left.

Treating Cancer with X-Rays

By EDWARD LONDON

IT is difficult to conceive of the existence of a specific remedy for the treatment of cancer. The sum total of scientific research to date indicates that full reliance must be placed on three known methods, namely, surgery, radium therapy, and X-ray therapy. Dr. Isaac Levin, Chief of the Cancer Division of the Montefiore Hospital and Clinical Professor of Cancer Research of New York University and Bellevue Hospital Medical College, who has written quite a treatise on cancer therapy in "The American Physician," (for October and November, 1922), maintains that cancer is neither an infectious nor a systemic constitutional disease, but manifests itself as a local disturbance in a group of normal cells. It begins its development as a local transformation of a small group of normal cells into cancerous cells. Some of these transformed cells become disassociated from the primary tumor, and are transported to distant regions where they form secondary tumors, and the latter again produces a local disturbance.

It is difficult, therefore, to develop a truly specific method of treatment of cancer. Such a specific remedy would affect deeply the cancer cells only, and at the same time would be innocuous as far as the adjacent normal cells of the same organ are concerned.

Thus with surgery we try to remove normal tissue adjacent to the malignant tumor into which the cancer cells most frequently spread, and also to remove regional lymph glands. However, we cannot make much wider dissections than we are now doing, as the tumors or cancerous growths are usually situated in close proximity to vital organs, and amputation in their vicinity would endanger the life of the patient. Consequently, there is a limit to the length to which a surgeon may go in removing the normal tissues adjacent to the tumors. For this reason, cancer surgically treated very often comes back again. If we could remove tissues adjacent to the cancerous growths and prevent the spread of the cancer cells, our operative measures would be absolutely successful.

Radium and the X-rays act differently from surgery inasmuch as they are capable of destroying the cancer cells in situ without injury to the normal tissues. In the May, 1921, issue of SCIENCE AND INVENTION there was an article on the treatment of cancer by radium, illustrated profusely with photographs. The first effect of the radiations is a direct action on the cancer cells. This effect consists in the inhibition of the proliferating power of the cancer cells. When the cancer cells cease to divide, they grow old, degenerate and die. In the opinion of Dr. Isaac Levin, this degeneration and death of the individual cancer cells may not be directly due to the action of the radium and the X-rays, but takes place in the natural course of the life-cycle of the cancer cell. Each cell goes through a period of development or of youth, a period of maturity, and finally a period of old age, which gradually leads to death; the life of the individual cancer cell is very short, but in the natural course of events the cancer cells divide rapidly into two young daughter cells. The radiations of radium and the X-rays inhibit this division, and interfere with the growth of the cancer cells. The superiority of radium over the X-rays is due to the fact that a radium tube can be placed in close proximity to the cancerous growth or even in the form of radium emanation in tiny glass tubes can be inserted into the cancer itself.

The X-rays on the other hand originate at the target of the X-ray tube, and become greatly diminished in strength before they reach the cancerous growth. Consequently,

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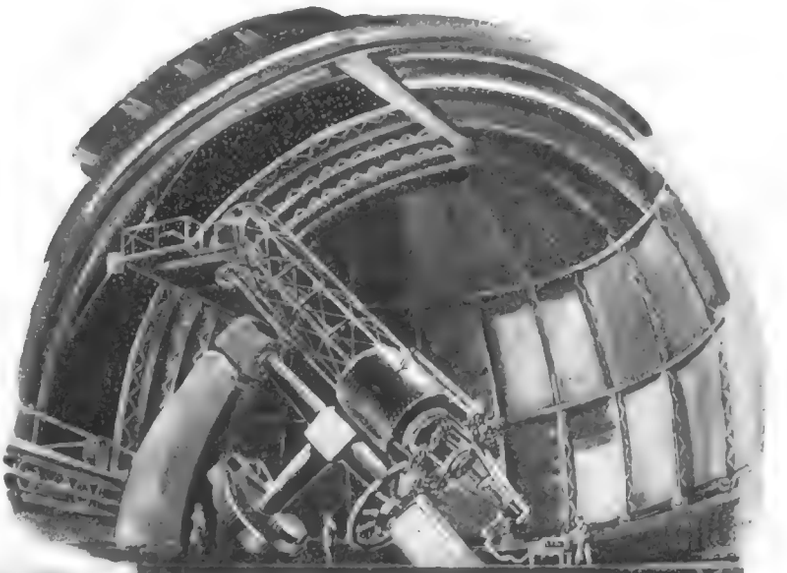
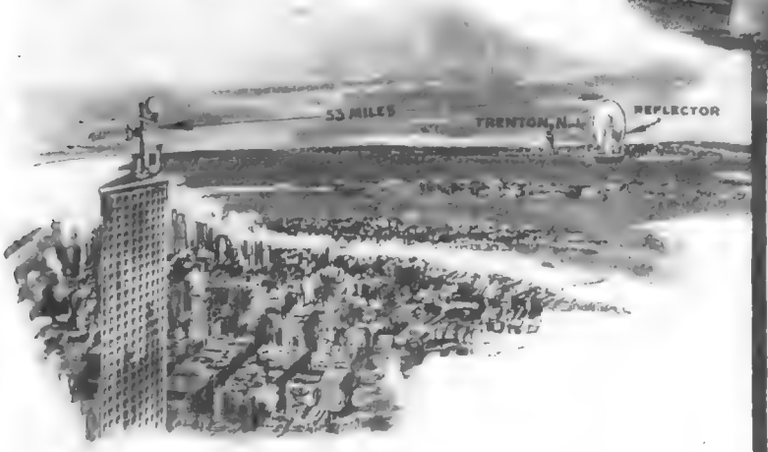
Measuring the Heat from the Planets

DONALD H. MENZEL, M. A.





The Uppermost Photo of All Shows Three Pictures of Mars—Note the Dark Areas and the Polar Ice Caps. The Lower Heavenly Body Shown is Jupiter, its Heavily Clouded Surface Forming a Striking Picture When Seen Through the Telescope. The Present Article by Mr. Menzel of the Graduate College of Princeton University, Describes the Measurement of the Heat Radiated by Distant Planets. The Heat Measuring Device Used Would Be Affected by the Heat From a Candle Fifty Three Miles Away, as Shown Below. Pictures at Right Show Huge Telescope of the Type Used in Making Measurements.

FOR many years astronomers have been in controversy over the temperatures of the planets. Hundreds of theories have been advanced and the figures obtained have ranged up and down the thermometer so inconsistently that the question of what their temperatures are has remained unsettled up to the present day. It has long been recognized that the only solution of the issue would involve careful study and observation, but here arose a difficulty, for even to detect the heat from the planets, let alone measure it, requires an apparatus of the greatest sensitivity.

From known laws of physics it is not a difficult matter to calculate theoretical temperatures as we know the amount of the sun's heat available for warming the surface, but to determine this exactly requires some knowledge of the materials composing the face of the planet and the amount of shielding by its atmosphere.

To attack the problem a thermocouple was constructed, an instrument so delicate that the heat from an ordinary tallow candle fifty-three miles away would, if focused upon it, cause a very perceptible deviation. If this amount of heat were allowed to fall on a single gram of water, six hundred million years would be required to raise its temperature from freezing to boiling. Even the planets radiate more heat than this.

At the surface of the planet some of the heat of the sun is immediately reflected and some absorbed, but it is only the latter that has any part in heating the planet. Therefore, the total heat received at the reflecting telescope is composed of two kinds, reflected and radiated, and we would be no better off than before as to knowing the temperatures involved were it not for the fact that the two kinds can be separated. A thin-walled transparent cell of water placed in the path of the rays will absorb the planetary heat while letting that reflected from the sun pass through little diminished in intensity.

Even after measuring the two kinds of heat the task is not finished because some of the original energy was absorbed by the earth's atmosphere and this must be replaced by calculation before we finally reduce to temperatures. It is evident that these calculations apply only to that part of the planet that is doing the radiating and as this may be fairly high in the atmosphere we will still have to guess at the surface temperatures, although probably we shall not be much in error.

Of all astronomical bodies, perhaps the one most discussed has been the planet Mars. Investigators have assigned it temperatures ranging from forty degrees below zero Centigrade to more than twenty degrees above. At the equator it is found that the highest temperature reached by the radiating layer is some few degrees below freezing, but the additional protection of the atmosphere probably raises the value for the surface somewhat higher so that the observed phenomenon of the disappearance of whitish areas at the poles is undoubtedly due to the melting of snow and ice.

However, the atmosphere of Mars is very much thinner than our own; in fact, less dense than the rarefied air at the summit of the earth's highest mountains. With this little shielding it is not surprising that the calculations indicate an enormous temperature fall during the night, when, in the cold frosty hours before sunrise, a frozen Martian plain may have a temperature seventy or eighty degrees below zero C. The orbit of Mars is so eccentric that its distance from the sun varies much more than that of the earth and the seasonal changes are correspondingly more severe, so at the time when farthest from the sun it is questionable whether any part of the planet can have a temperature above freezing.

We now turn to the planet Venus, an astronomical enigma for, although its atmosphere is not quite as dense as our own, heavy clouds hide the surface features so completely, that to this day the period of rotation is left in doubt, having been placed

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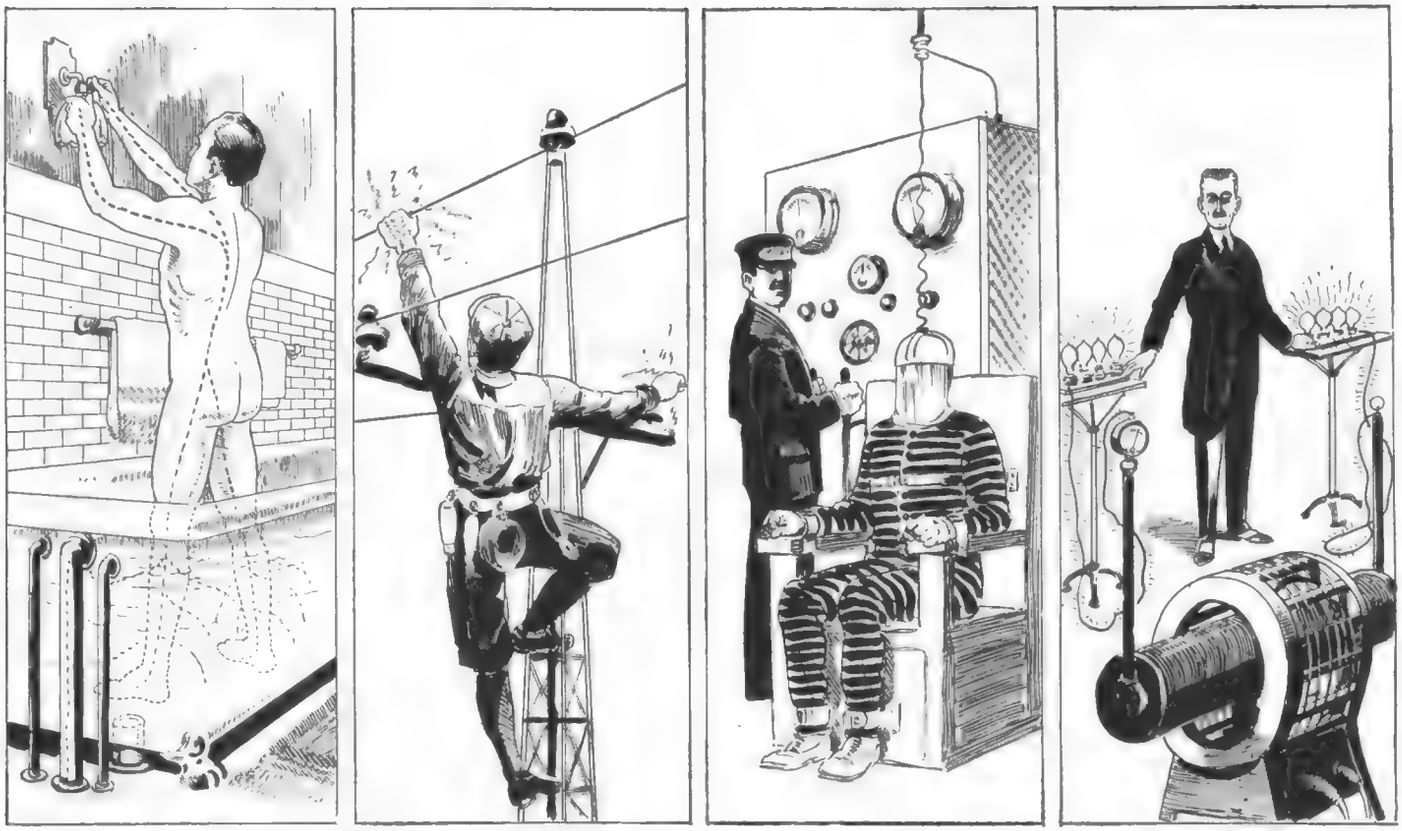

As Pointed Out by Dr. Wenner of the U. S. Bureau of Standards, a Potential Drop of Two to Three Volts Within the Body, with a Current of One-tenth Ampere Passing, May Cause Death. Every Now and Then We Read of a Fatality Due to Someone Standing in a Bathtub Immersed in the Water Up to Their Knees, and Touching a Grounded Electric Fixture. One Reason Why a Fatal Shock is Sometimes Received from What is Usually Considered a Low Voltage Circuit, is Due to the Greater Contact Area Afforded by the Water and Wet Skin. This Effectually Lowers the Electric Resistance of the Body and a Much Heavier Current Than Normal Passes, Which May Prove Fatal to an Individual with a Weak Heart. With a Body Resistance of Say 1,000 Ohms, a Current of .1 Ampere Will Pass at a Potential of 100 Volts. In the Electric Chair 1800 Volts, 60 Cycle A. C. is Used, the Current Through the Body Being Seven to Ten Amperes. A Lineman Who Completes a Circuit Across a 30,000 Volt Transmission Line, or from One of These Wires to Ground, May Permit a Current of One to Three Amperes or More to Pass with, of Course, Fatal Results; at 30,000 Volts and 10,000 Ohms the Current Would be 3 Amperes. An Electric Paradox is Represented by the Gentleman Passing Several Amperes of High Frequency Current Through His Body and Lighting Several Lamps, as Shown in One of the Pictures, the Potential Being Possibly a Million Volts or More. This High Frequency Current Passes Mostly Over the Outer Surface of the Body, and Does Not Penetrate to the Nerve and Muscle Centers.

How, When And Why Does Electricity Kill?

By M. McCABE

ELECTRICITY is today one of the greatest servants of man. The automobile, telephone, trolley, radio, submarine are all inert mechanical devices till fed with the subtle force that makes the whole world go 'round. But every so often it strikes back, sudden and swift as the lightning that mothered it, and a human life is snuffed out, perhaps a part of the price mankind must pay for services rendered. But the how and why has survived countless controversies.

Tell the average person that 1,800 volts are used to electrocute criminals. Then tell them the coil in their car develops over 15,000 volts, and they stand aghast. It is enough to kill, but it does not, except in unusual conditions, where the shock to the nervous system and not the current flow itself causes death.

To state offhand that a certain voltage will kill means nothing; there are a number of factors that must be taken into account when considering death by electricity. A heavy flow of current through the body paralyzes the muscles and vital organs, destroys the nervous system and may disintegrate the blood. The extent of these injuries depends chiefly upon the amount of energy expended in the body. Hence, we might rate the killing energy in watt seconds. But we find that at higher voltages and frequencies we can expend harmlessly an amount of current in the body, that would cause death at lower voltages or frequencies. As an approximate rating of a minimum current value that will produce death, it has been found that one-tenth ampere through a vital organ will result fatally.

"A voltage drop of 2 to 3 volts within the body, with one-tenth ampere, may kill," says Dr. F. Wenner, of the U. S. Bureau of Standards.

The voltage necessary to produce death is then one great enough to force a fixed minimum current through the body and will therefore vary both with the amount of contacting surface between the body and the live conductors as well as with the resistance of the portion of the body through which it flows. Furthermore, the resistance of the body will vary with the applied voltage; at low voltages it is as high as 35,000 ohms, while with voltages of the order of 100 the resistance drops to the neighborhood of 12,000 ohms. The reason for this is that the dry skin is a poor conductor of electricity normally, but under the higher voltage this resistance is broken down and the current readily enters the muscular tissues of the body which are by nature of their constituents good conductors with a low resistance.

This is further shown where moistened electrodes are used as in the case of electrocution. With a potential of 1,800 volts applied to the death-chair, the ammeter reads between 7 and 10 amperes or approximately a resistance of 200 ohms. This explains why a greater shock is felt when the hands are moist and why death may result from touching a live wire of even 100 volts potential, while in the bathtub with the body partially immersed in water.

It will be clear that the resistance of the body is also controlled somewhat by conditions. On a hot summer day, when covered with perspiration, the resistance is naturally lower than when the skin is dry. Therefore, a voltage that might kill one in July might only result in a painful shock in February.

So far the results of poor contact with high voltage conductors has not been covered. Under these conditions the parts of the body in contact are usually badly burned, at times sufficient to demand amputation, while the person may survive. Another factor is the length of time the current flows through the body, for on this depends the amount of energy liberated in the body. Thus a current that may only be painful with severe muscular contractions may result seriously if the contact is maintained for any length of time. This consideration becomes important when it is realized that the common voltage of 550 is not great enough to cause instant death, but may paralyze the muscles and cause a continuation of the contact that will result fatally. The person so held in the circuit is usually incapable of movement or speech and is helpless to summon aid and cannot detach himself.

It will be seen from the above that we have a number of interrelated factors to consider in determining the deadliness of a

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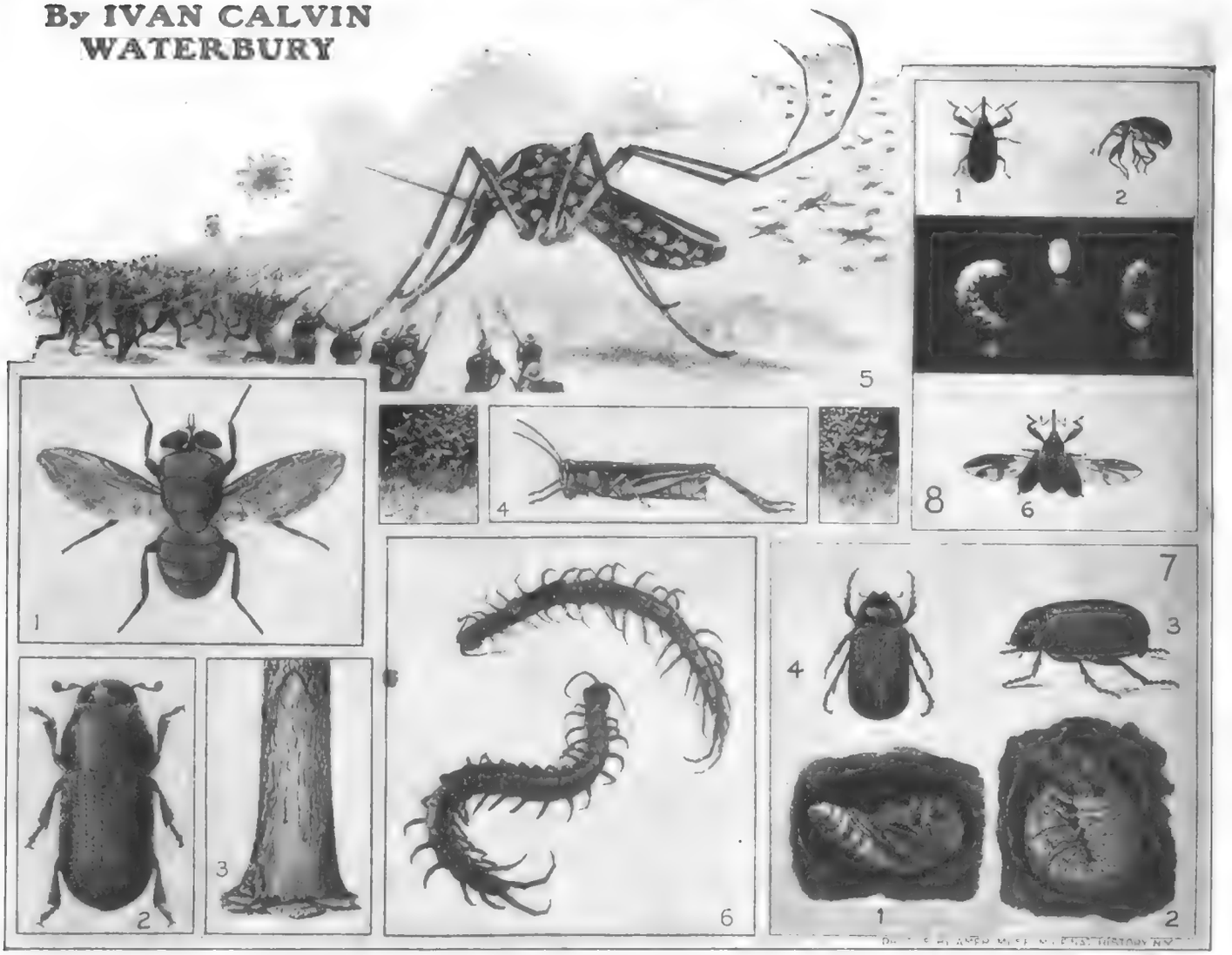
Man's Chances Against Insects

By IVAN CALVIN WATERBURY



1—Green Bottle Fly. A deadly pestiferous enemy of man and beast, of astounding fecundity. 2—Dendroctonus ponderosa (adult). The beetle that lays desolate miles of western yellow pine forests. 3—Work of the Dendroctonus beetle on western yellow pine. Its egg galleries or grooves destroy the cambium or growing tissue of the tree. 4—Melanoplus bivittatus, female. A transcontinental ravager of grain and also alfalfa and other crops. 5—Yellow Fever Mosquito. (Aëdes Calopus). Its habit of resting horizontally distinguishes it from the malaria mosquito. 6—Centipedes (Scolopendra Alternana). A friend of the household which is death on bedbugs. 7—May Beetle: 1, pupa in earthen cell; 2, larva or "white grub"; 3, adult from side; 4, same from top. May Beetle or "June-bug" (Lachnosterna fusa) trans-continental in its destruction of grain. 8—Cotton Boll Weevil which in five years has destroyed about $1,900,000,000 of cotton, and against which war-gas is to be turned, in a billion dollar bug-war by the Government.

CHINCH-BUGS destroying fully $46,000,000 worth of corn, wheat, oats, and forage sorghums in the United States every year exemplify the way insects cut in behind man's food bases. The destruction of over $1,600,000,000 worth of cotton in the Southern States by the Mexican boll-weevil in the last five years illustrates the prowess of another insect unit.

Then there are plagues of grasshoppers, potato-bugs, and potato-weevils; of sheep-ticks and cattle-ticks; of army-worms, cockroaches, and many kinds of ants; of tree-destroying beetles, and so many others as to make Dr. L. O. Howard's ingenious little corps of entomologists in the Department of Agriculture seem like a forlorn hope against enemies individually insignificant but mobilizing hosts as terrible in the aggregate as the seven-horned Beasts of the Apocalypse.

Working more insidiously than the peaceful penetration of Boche or Bolshevist, many species go armed with deadly bacteria and protozoa with which they deal death in epidemics to whole communities. One kind of mosquito (Aëdes calopus) inoculates yellow-fever, another (Anopheles) malaria. Flies implant the bacteria of typhoid fever, dysentery, and other intestinal diseases in people's food, and, in contact with soldiers' wounds, their maggots cause myiasis. Body-lice carry typhus. The fleas on ship-rats bring bubonic plague from the Philippines, South America, and other distant climes. In many species this disease-bearing power is as deadly as chemical warfare.

Another insect advantage lies in adaptability to sudden changes of diet, or even getting along without food. For instance, the bedbug can live practically a year without food of any kind; so, if a man goes into a house that has been vacated by all but the bugs for 360 days, he will still be liable to save the bugs before the year-end week is out. On some insect-parasites sudden shifts of climate have no detrimental effect. Bedbugs and fleas haunt man from the Equator to the Arctic and Antarctic regions, where they can still be fruitful and multiply at a frightful rate. The malarial mosquito, which makes it impossible to exploit valuable sections of the Gulf States, also hatches in the coldest mountain-streams, and thrives just as formidably in Alaska and Greenland. Yellow-fever mosquitos are brought in fruit vessels from the tropics to New York and Philadelphia, thus causing the terrible epidemic far north in the Forties.

Most dreadful of all is the fecundity of man's insect enemies. This alone would crowd mankind off the earth if the insects were not as a house divided against itself, one species preying upon another. More ominous still is the fact that the destruction of one species of insect may, by the irony of fate, only serve to favor the increase of others. There is no telling when an obscure local species will suddenly burst forth in vast multitudes upon an astonished world, as did the Colorado potato-beetle in the Eighties, and the potato-aphis in 1917.

Man has the disadvantage, in his life-history, of years of helpless childhood, but many insects are most harmful in the embryonic stages represented by their successive metamorphoses, as in the case of the voracious white grubs of the June-bug, or May-beetle, so destructive to young grain, forage, root-crops, strawberries, and seedling trees. Similar is the case of the Dendroctonus beetles that devastate so many pine forests, and of other beetles, butterflies, and moths.

Before the World War was under way, the entomologist was regarded by most people with about the same indulgent levity as the spring poet. Then it transpired that the destruction of grain in storage and in transit by weevils and other insects cut down the troops' food-supply, and that body-lice carried trench-fever and typhus that ravaged the troops on the firing line, while

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Old Time Optical Instruments

By T. O'CONOR SLOANE, PH. D.

JUST what interest the Kircher Museum in Rome excites in the present day is somewhat uncertain, but in old days it was one of the attractions of the Eternal City, and there are at present in existence several ancient folios naturally of very great rarity and of equal interest, relating to this museum, describing its contents and illustrating the same, by what we would consider the somewhat crude engraving methods of two or three centuries ago, although to the artistically disposed person there is much of interest in the personal touch which characterizes these productions. Many of the objects illustrated are very familiar to us. Those were the days when classification and subdivision had not been carried out to its present extent, and the Museum Kircherianum, as it was entitled in Latin, covered all the curiosities and objects of interest of the world. There are numerous plates in these old volumes illustrating shells, all perfectly drawn, and showing many of the conchological treasures of the present-day collector, a few animals and other objects are illustrated, but what we are especially interested in and reproduce here are some pictures of optical instruments, which show how far the scientists of the seventeenth century had progressed in the field of optics. While the instrument maker of today would produce far different apparatus from what we show, it is clear that the difference would be rather in design than in construction. The drawings indicate first class mechanical work, and show an astonishing advance, when we consider the time in which they were produced.

The Kircher Museum was named from the Reverend Athanasius Kircher, a Jesuit priest, whose activities covered an astonishing wide range of science, and to him is accredited pretty definitely the invention of the *magic lantern*, a toy, if we go back to the days of the present writer's childhood, and which now is at the basis of one of the great industries of America, the moving picture world. In some of the older books, Kircher gives pictures of his first magic lanterns, which were of very crude construction, and whose principles were quite primitive. Some of them seemed merely to throw silhouettes of pictures painted on glass slides upon a wall in a darkened room. Comparatively few people realize the peculiar function of a projection apparatus. It amounts to focusing a shadow, and too little emphasis has been laid upon this feature by writers on the subject. So it is rather interesting to find that the projection lens or objective was omitted in some of the earlier attempts of producing a magic lantern, but that very soon the objective was made a part of the mechanism and in the primitive lantern we show here we have along with the lantern condenser and lantern slide, a true objective, and the whole apparatus is mounted in thoroughly mechanical style, with rack and pinion motion for the objective as well as a screw adjustment for the same, and in front of the structure there is a forked support to take up the weight of the lens. The picture is so good and speaks so well for itself that a description seems hardly needed, but there are one or two points to be specially mentioned.

The great deficiency centers in the lamp. Thousands of years passed before man succeeded in producing an artificial light of any but the most meager intensity, and here it is evident that the lamp used by Kircher gave but the scantiest light, and was the crowning defect of his apparatus. It did

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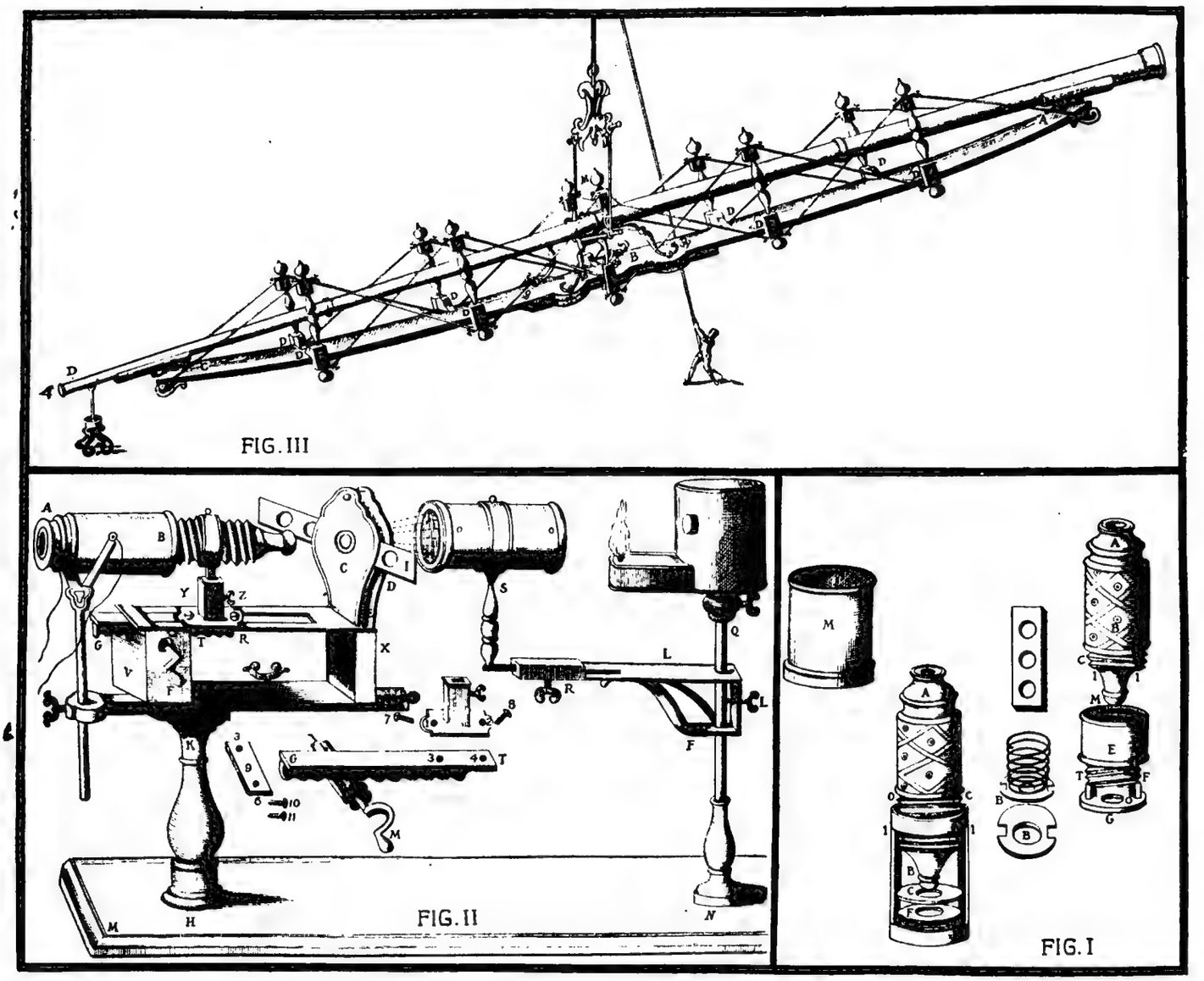

Fig. 1 Shows a Historic Microscope Dating Back Several Centuries. All of the Illustrations Herewith Were Taken from a Rare Book in the Astor Library, New York City, Which Bears the Date of 1709, but the Articles Were Written Before 1680. Fig. 2 Shows the First Magic Lantern, While Fig. 3 Shows an Early Model of a Large Astronomical Telescope. Note the Elaborate Trussing Used in Order to Keep the Tube Straight.

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Popular Astronomy

By ISABEL M. LEWIS, M. A.
Of U. S. Naval Observatory, Washington, D. C.

If Our Sun Should Become a Nova

NOVAS, or temporary stars, are not *new* stars in the sense of having been newly created, but are previously existent stars temporarily performing strange antics. Some insignificant, telescopic star, suddenly, in the course of a few days, or even hours, increases in brightness manyfold and leaps from obscurity into the ranks of the first-magnitude stars in a single night, then rapidly and fitfully, like a dying ember, parts with all of its suddenly acquired glory in the course of a few months. Observations of the star after its sudden outburst show that it is surrounded by a nebulous envelope of considerable extent and that its atmosphere is in a most abnormal and agitated condition.

Only exceptional novas, however, attain naked-eye visibility and we may count on our fingers the number that have equaled or excelled first-magnitude stars in brightness. In the past twenty centuries less than a score of novas have been recorded as visible to unaided vision. Consequently it was believed up to a few years ago that the advent of a nova was a most unusual celestial phenomenon and that the nova itself was a sort of stellar freak.

After the sensational appearance of Nova Aquilae No. 3 on the night of June 8, 1918, a nova which for a few days surpassed in brightness all of the stars except Sirius, it was decided to make a systematic search for novas on photographic plates that have been taken at the Harvard College Observatory within the past thirty years or so. The most significant fact that has been brought out by this search is that the appearance of a nova is not a rare occurrence, but an every day sort of a matter, though the vast majority of novas are fainter than stars of the sixth magnitude at maximum brightness and so cannot be seen with the naked eye.

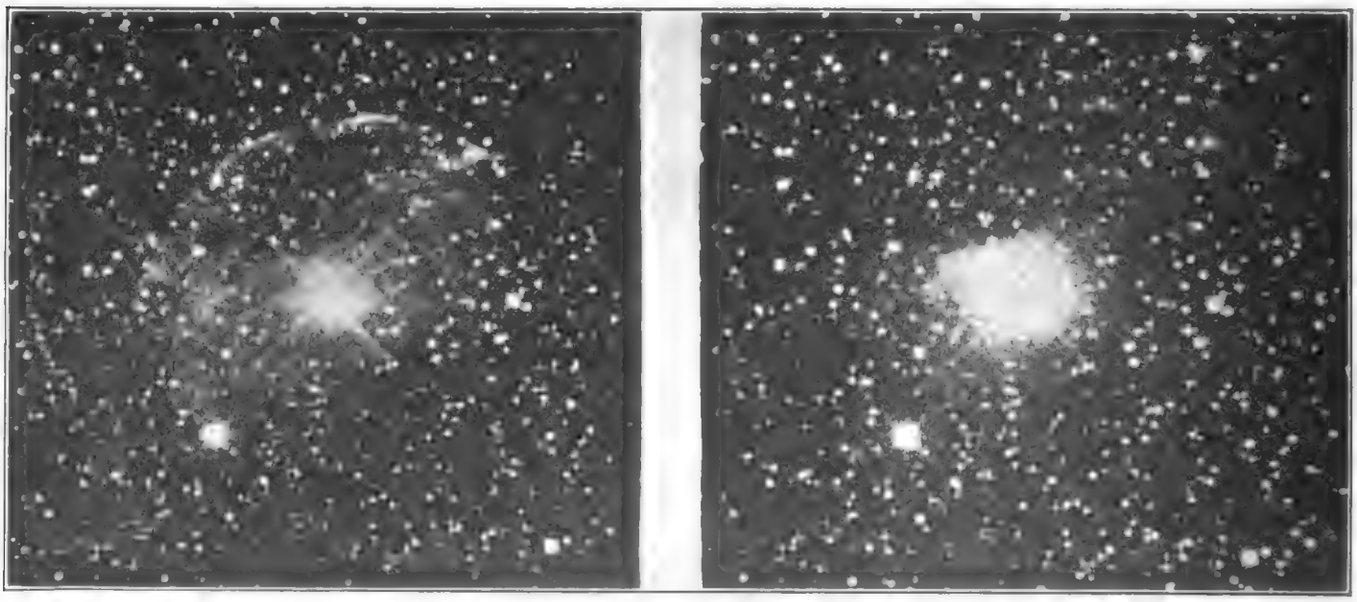
That most novas are invisible without the aid of the telescope is probably due largely to the fact that the celestial catastrophes that they typify have occurred at enormous distances from the earth while the novas that attain to the magnitude of first-magnitude stars are comparatively near to us in space.

The number of novas discovered on the Harvard plates has increased so rapidly in the past few years that the announcement of the discovery of a telescopic nova now fails to arouse any more excitement than the discovery of one of the numberless asteroids of the solar system. Though the outburst of a nova is an indication of a celestial catastrophe on a gigantic scale, it is, then, a matter of common occurrence. A little computation has shown that within the billion years or so that have elapsed since the earliest geological age as many novas must have burst forth, at their present rate of appearance, *as there are now stars in the heavens.* As the period of a star's life is, beyond doubt, considerably greater than a billion years, there seems good reason to believe that all the stars, including, of course, our own sun, have passed at least once and possibly several times through the nova stage.

From a study of the photographic plates which show the brightness of some typical novas over a period of a number of years prior to their outbursts it has been found that noticeable fluctuations in the brightness of the star have often occurred before the final outburst that puts it in the class of a nova. In other words, many irregularly variable stars have become novas. It is possible that all novas have gone through peculiar light fluctuations for a number of years, possibly for centuries, before the final catastrophe has taken place, though observations of novas have been too limited as yet to settle this point. As to the cause of the outburst of a nova there is great uncertainty. It cannot be said definitely that the outburst is due to the encounter of the star with a dark nebula or a cloud of cosmic dust drifting through space, though this is the view generally favored. It is possible that the outburst may be due to abnormal conditions that exist within the star itself. At present our own sun goes through more or less regularly recurring periods of maximum activity. At such times solar cyclones, known as sunspots, appear almost continuously in its atmosphere and incandescent vapors of many metallic elements leap to unusually great heights above its surface with high velocities. The forces that produce these outbursts of unusual activity in the sun are unknown, but it is generally believed that they reside within the sun itself, though some favor the theory of external causes. Certain types of variable stars go through periods of light change that resemble in some respects the sunspot period and some irregularly variable stars have spectra that resemble the spectra of sun spots. As irregularly variable stars have been known to go through the nova stage in some instances, it is possible that the forces that operate to produce the sunspot cycle of change in solar activity may also be the forces that produce the irregular fluctuations of many variable stars and the celestial catastrophes that attend the outbursts of novas. If our own sun, in common with other stars, is to pass at some future date through the nova stage it is probable that it will exhibit for a long period prior to the catastrophe irregular fluctuations in brightness to a marked degree. Whether these fluctuations will be due to abnormal internal conditions leading up to the final outburst, or to the encounter of the sun with stray wisps of nebulosity from a cosmic cloud that is later to cause the catastrophe it is difficult to decide until more is known of the nature of these outbursts. It is also possible that the outbursts of novas may be due to neither of these causes, and are of entirely unknown origin.

It has been found that the typical nova immediately after its maximum outburst

(*Continued on page* 75)



The Two Photographs Show Nova Persei, the Photo to the Left Showing the Star as Photographed by the Yerkes Observatory, September 20, 1901; the One to the Right Showing the Same Star as Photographed November 13th, 1901. This Star, Which Previously Had Been Only a Very Small One, Burst Into Luminescence, a Nebula Being Formed as Shown in Our Left-Hand Photograph. This nebula, as Will Be Noted, is of a Tremendous Size and is Many Million Times as Large in Diameter as the Original Sun. After the Outburst the Nebula Shrunk, and Nova Persei Has by This Time Resumed Its Pre-catastrophical Appearance.

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WILL THIS BE THE END OF THE WORLD?

In the Heavens One of the Most Common Occurrences is the Flaming Up of a Star to Many Times Its Original Brilliancy. Such Celestial Cataclysms Are Not at All Unusual. When it Does Happen, the Star Expands Enormously, While the Fiery Envelope Extends Over an Immense Amount of Space. Our Sun is, of Course, a Star, and the Chances Are That it Went Through just Such an Evolution Many Times During Its Past History. Should the Cataclysm Arrive Again, All of the Planets Will Be Engulfed in a Sort of Nebula, as Here Pictured, but With the Sun Remaining Much as it is Now. Such a Simply a Sort of Explosion that Hurls Out Into Space a Sort of Nebula. Such a Cataclysm Would Wipe Out All Life on Earth in the Twinkling of an Eye. Due to the Tremendous Amount of Heat Generated in the Process. But Geologists Can Prove to Our Satisfaction That Such a Cataclysm Has Not Occurred at Least During the Past 400 or 500 Million Years, and the Chances Are That it Will Take a Long Time Before it Will Appear Again.

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"Miss Gloria Mundy Pressed Down the Radio Control Key. Instantly a Cloud of Flame and Smoke Was Belched Up from the Volcano, Huge Blocks of Lava Being Hurled Up High Into the Air. It Was Only Several Seconds Later That the Report Could be Heard, for Sound Travels Far More Slowly Than Light. The Earth Shook Violently and Several Ramshackly Buildings Fell. Some Window Panes Were Broken, Although People Had Been Warned to Leave the Windows Open to Avoid Such Breakage."

Doctor Hackensaw's Secrets

By CLEMENT FEZANDIE

No. 16. The Secret of the Earthquake

(*Author's Note. Man has made one conquest after another over Nature. So far, however, he has been unable to control her volcanoes or prevent her earthquakes. There is no reason, however, why he should not some day be able to bring both of these under his dominion.*)

"HULLO, Silas! What in the world are you doing here?" The speaker was Doctor Hackensaw, who was standing on the upper deck of the French steamer about to sail from its pier in New York.

"I just came to see a friend off. But you, doctor, you're surely not sailing for Europe?"

"I *am* that, Silas," returned the doctor. "I happen to have a little free time on my hands, so I'm off to Italy to tame Vesuvius."

"To tame Vesuvius? What in the world do you mean?"

"Ah, you see, Silas, man has been winning victory after victory over Nature. We have harnessed up her waterfalls to run our dynamos, and defied her laws of gravitation with our airplanes. Our submarines have even invaded the ocean depths she had appointed to the fishes, but so far we have made no attempt to conquer her volcanoes or subdue her earthquakes."

"Why, I had understood that there was an observatory established on Vesuvius to make seismological records, and study the eruptions. I was even told that they are making spectroscopic observations of the flames."

"That's true enough, Silas, but that is only the first step. These scientific records that are being made, will some day enable us to predict with accuracy when an eruption or earthquake is menacing, and whether it will be great or small. But from that to controlling the internal forces at will, is quite another matter."

"And you think you can accomplish that?"

"I can at least try. And even if I fail in this, I may nevertheless succeed in the simpler task of harnessing up Vesuvius, and making it of use to mankind."

"In what way?"

Simply this. Inside of Vesuvius, and near the surface, there must be a mass of red-hot lava, capable of producing heat, light, and power in practically inexhaustible quantities. A few miles away lies Naples—a city that spends large sums importing coal to run its trolleys and trains, work its factories, and furnish its light and heat. Now, why not make Vesuvius do the work and so afford the volcano an outlet for the tremendous energies pent up within it?"

"The idea seems good, but how would you set about it?"

"At first I had intended to be satisfied with supplying Naples with hot water. This would be the simplest scheme. At Solfatara, just a few miles away, there already exists a natural boiling spring. Artificial ones could be made in the same way. My plan was to lay pipes through the hot lava beds near the center and have the water heated as it passes through. I should, of course, have to choose spots where the heat was constantly renewed."

"Wouldn't your pipes melt?"

"The pipes could be of tile or some other refractory substance. My idea was to make them of cooled lava, and have the volcano itself mould the pipes for me. The moulds would be prepared, and at a given signal the molten lava from the crater would be allowed to run into them. I had some preliminary experiments made in the small and easily accessible crater at Solfatara, and found the scheme quite feasible. These pipes could be of large diameter and well insulated, so as to preserve their heat."

"I suppose the water supply on Vesuvius is ample?" hazarded Silas. "Your scheme would require a tremendous amount of water."

There is no water on Vesuvius. But the Mediterranean Sea—or at least that portion of it called the Bay of Naples, lies at its

(*Continued on Page* 81)

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What A Population of Six Million Means

By CHARLES NEVERS HOLMES

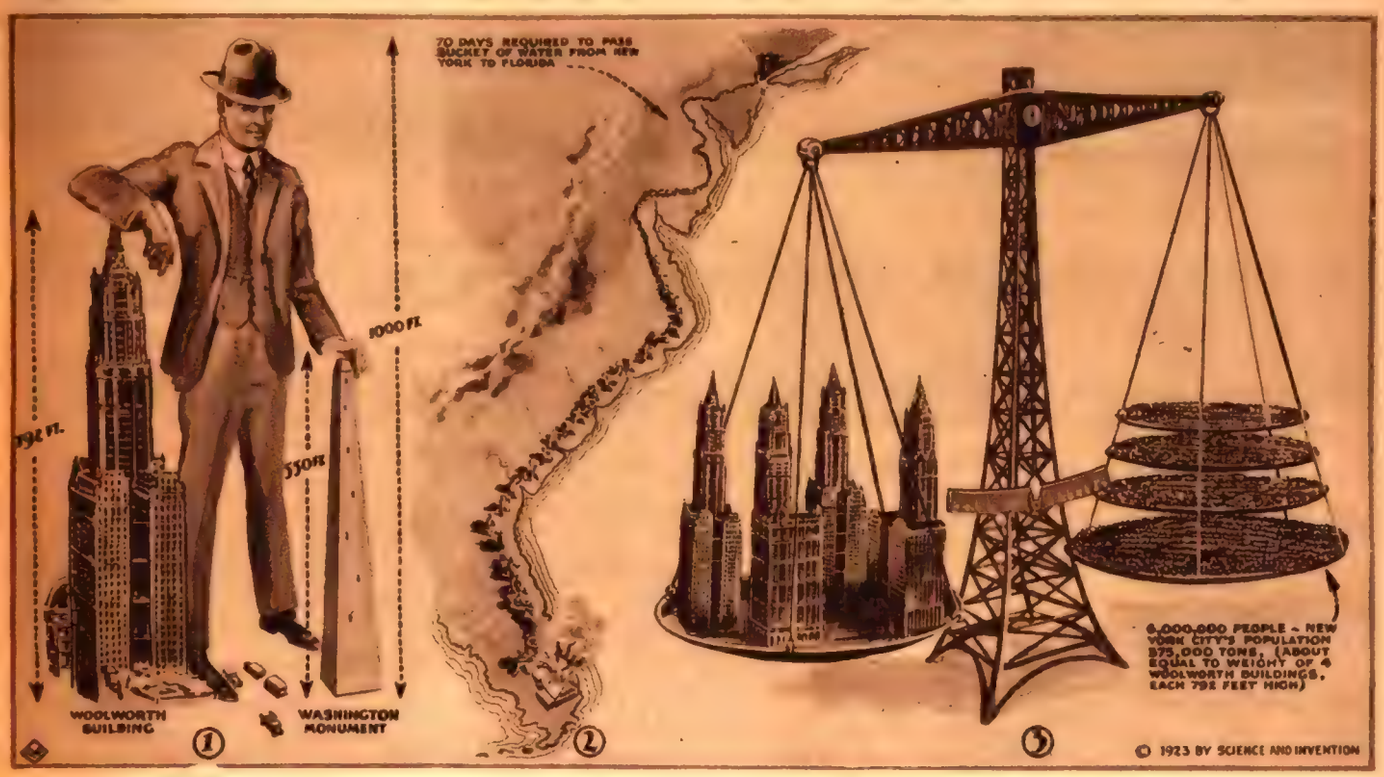
IN 1696, the population of what is now the Metropolis of New York, amounted to 4302. In the year 1790, its population had increased to about 50,000. This was somewhat larger than the combined populations of Indiana, Illinois, Michigan and Arkansas twenty years later. New York kept on growing: it had more than 100,000 inhabitants in 1810, more than 200,000 in 1830, and more than a million in 1860. It kept on growing. In the year 1890, about 2½ million people resided in its boroughs of Manhattan, Brooklyn, Bronx, Queens and Richmond. In 1900, about 3,437,000 people dwelt in these five boroughs; in 1906, 4,000,000; and in 1913, more than 5,000,000 people. According to the last United States census, New York City contained 5,620,000 inhabitants, and today its total population approximates 6,000,000.

These six million New Yorkers are divided among the five boroughs, approximately, as follows: Manhattan, 2,300,000; Brooklyn, 2,150,000; Bronx, 850,000; Queens, 550,000; and Richmond, 150,000 inhabitants. That is, the borough of Manhattan has increased in population, since 1820, about 18 times; Brooklyn, about 190 times; Bronx, 305 times; Queens, 66 times; and Richmond, about 24 times, and the total population of New York City is about 40 times as large as it was a century ago, or about 4 times as large as it was 50 years ago. With respect to New York City's greatest growth, that occurred between the years 1890 and 1900, an increase of more than 900,000. And from the year 1900 to the year 1922, the population of the Metropolis has increased about 75 per cent, or, each year, by an average of nearly 117,000 people.

Now, what does New York City's present population (six millions) really mean?

If we could place New York City's total population so that each man, woman and child stood one above another, straight upwards from the ground, its six million inhabitants would extend to a height, approximately, of 6,000 miles. If we could place all this population side by side, shoulder touching shoulder, it would extend about 1300 miles, or a distance equal to that from New York City to a point about 100 miles south of the southern end of the state of Florida. If all these people could be weighed together, their total weight would approximate 375,000 tons, which would equal the weight of a cube of hard anthracite coal 188 feet in each of its dimensions. Were every New Yorker to form in a line, as was done years ago in case of fires, and, were they to pass a bucket full of water from one end of that line to the other end, taking one second to pass that bucket from each individual to his neighbor, the bucket would travel from New York City to a point about 100 miles south of the southern end of Florida in about 70 days.

Such a population approximates 1/19th that of our forty-eight states, or 1/283rd of our world's population. It is equal to the combined populations of the states of Arizona, Delaware, Idaho, Montana, Nevada, New Hampshire, New Mexico, Rhode Island, Utah, Wyoming and Louisiana. And it is equal to the combined populations of the following cities: Baltimore, Boston, Buffalo, Cincinnati, Cleveland, Detroit, New Orleans and Los Angeles, as well as several hundreds of thousands additional inhabitants. In other words, New York City possesses a population which approximates 6,000,000, but were it to include certain cities in its vicinity, it would then approximate a total population of more than 7,000,000 people. New York City's inhabitants dwell within an area of 318 square miles. That is, there is an average of about 19,000 men, women and children to each square mile of this great Metropolis. Or, each New Yorker should possess about 1467 sq.ft. of soil.


70 DAYS REQUIRED TO PASS BUCKET OF WATER FROM NEW YORK TO FLORIDA
1000 FT.
792 FT.
550 FT.
WOOLWORTH BUILDING
WASHINGTON MONUMENT
1
2
3
6,000,000 PEOPLE - NEW YORK CITY'S POPULATION 375,000 TONS, (ABOUT EQUAL TO WEIGHT OF 4 WOOLWORTH BUILDINGS, EACH 792 FEET HIGH)
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New York's Six Million Population Does Not Mean Very Much to the Average Person Perhaps, But the Artist Has Shown Us Vividly in the Accompanying Picture Just What Six Million People Amount To. If These Six Million People Were Represented by a Gigantic Man, He Would Measure 1000 Feet in Height, by 180 Feet in Breadth, and Be 75 Feet Thick Through the Chest. The Second Illustration Shows That These Six Million People, if Formed Into a Bucket Brigade Extending from New York City to the Southernmost Point of Florida, a Distance of 1,300 Miles, Could Pass a Bucket of Water Along This Route in Seventy Days. The Final Illustration Shows the Relative Weight of These Six Million People Which is Represented by Four Woolworth Buildings, or Approximately 400,000 Tons, the Woolworth Building Itself Weighing 100,000 Tons.

Noiseless Trolleys

The twin cities of St. Paul and Minneapolis are to have the first noiseless street cars in the world. At least, such is the plan of the Twin City Rapid Transit Company, which has been conducting experiments at its St. Paul shops with this objective, according to a recent announcement by Julian McGill, Vice President.

Trucks are being made at the shop which are equipped with roller bearings and will be installed under cars late in April.

"We are endeavoring to give our cars this ultra-modern touch, and believe the design now being used in the experiment will solve the problem," Mr. McGill said. "The roller bearing will make the cars virtually noiseless and will save the company a large item in power."

According to Mr. McGill, the roller bearings will make street car operation almost as noiseless as eight-cylinder automobiles, remove friction in the truck shafts; save 12 to 15 per cent. of the power and enable operators to start and stop cars more quickly.

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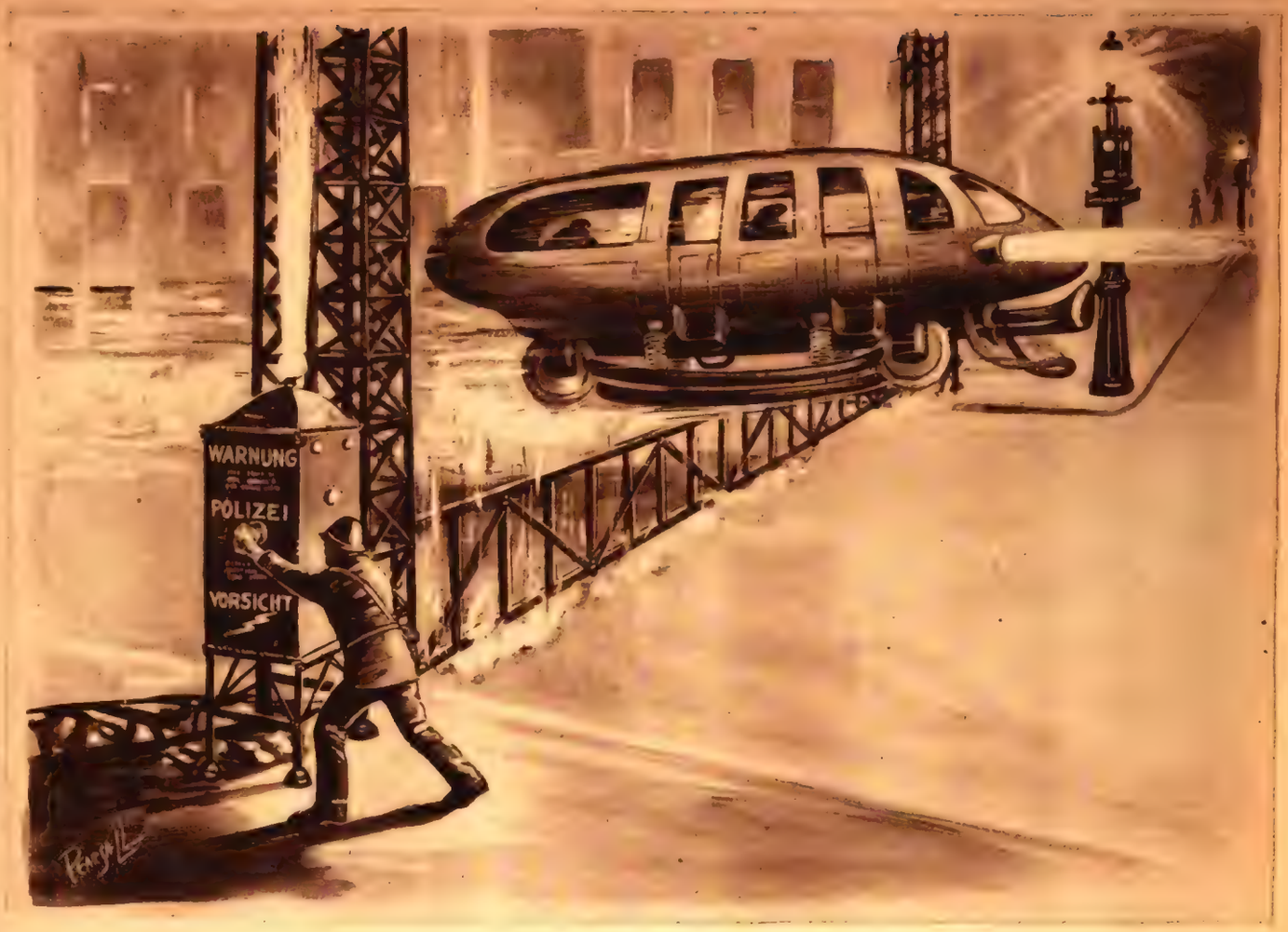

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"The Officer Sprang to One Side and Pulled Out the Handle Which by Electric Action, Drew a Steep Barricade Across the Street Crossing. The Burglar Was Not Going to Escape Him Whatever Happened. But What Was That? Two Great Springs Appeared Suddenly on the Bottom of the Automobile Which Lifted It Up, and It Jumped As If It Was a Running Horse, Over the Barricade. Before the Officer Could Recover From His Astonishment and Give a Shot, the Automobile Had Disappeared in the Darkness of Night."

Hunting Criminals In 2000 A.D.

By FELIX LEO GOECKERITZ

THE acting officer of the Berlin *Staatspolizei* (Burglary Division), sat in his office and followed wearily the minute hand of the electric master clock, which gradually approached the midnight hour. The collar of his uniform was open, and he was turning over the leaves of a detective story. It was manifestly superfluous for him to take the functions of his office too seriously, for in the last fifty years the prevention and guardian divisions of the police had been perfected to such a fine degree, that only an idiot or a genius in the burglary line would think of breaking into a house. In his office the threads of a widely branched very phenomenal detection system came together, which had cost many thousands of marks, but also had absolutely stopped the burglars and robbers who had come into the field after the World War, now a matter of ancient history. The criminal statistics were reduced to isolated instances, and a practically ideal degree of safety ruled over the whole land.

Just now the clock with its light beat had announced the midnight hour, when suddenly on the white marble switchboard, covered with its innumerable incandescent lamps, a light appeared, coming from a tiny little reddish lamp, and at the same time shrill and persistent through the silent room came the sound of the alarm clock.

A Picture of the Police in the Year 2000

Hasty steps were heard in the corridor, and the next instant the police automobile was heard puffing and ready to go out on the street, while in the doorway the chauffeur stood ready to receive instructions from his superior.

Lieutenant Brillov jumped up from his writing table and read the number which in glaring white letters stood out from the signal lamp, "14752A"—the great "Bank of Commerce." He threw over a black switch, and at once innumerable hidden microphones on all the floors and all the rooms of the threatened bank were brought into circuit, which announced to the operators in the Police Department the slightest word and the least sound within the threatened building: Keys rattled, muffled steps were heard falling on the thick carpets. Now came a man's rough voice: "The police are having their blessed sleep, Timor. Wasn't it a fine thought of me to get you over on my side, you, the trusted guardian of the bank, but your houndlike loyalty gave me a bad job before I could get you, so as to come over on my side and to throw the alarm system out of circuit." Lieutenant Brillov gave a low joyful whistle through his teeth, and the waiting chauffeur, to whom the loud-speaker had clearly transmitted every word as if spoken in the very room, smiled. "We know one of them anyhow," said Brillov, "That is the watchman hitherto reported to us as absolutely faithful and reliable, but the good man never suspected that the cutting out of the alarm system at night would put this other system into circuit. So Schirmir, let her go, you know what to do, you won't have much work, it is only a bagatelle."

A short military turn—the automobile started into action, its shrill whistle sounded loud the next instant, while Brillov stepped to the telephone to notify the bank directors of the occurrence. Then he switched the secret microphone in again, and watched the sequence of events with halted breath.

The feverish hissing of an oxygen cylinder was heard on the loud speaker and then a slight noise, as if a piece of iron had fallen on the ground, a coarse laughing: "That didn't take long, Timor. Now quick, pack up the goods." And then a snarling curse. A voice of thunder came out of the apparatus. "Hold up your hands in the name of the law." A deafening sound, two shots, one after the other, muffled fall. Brillov laughed, "The mouse is in the trap, that was the falling of the door of the cage."

(*Continued on Page* 84)

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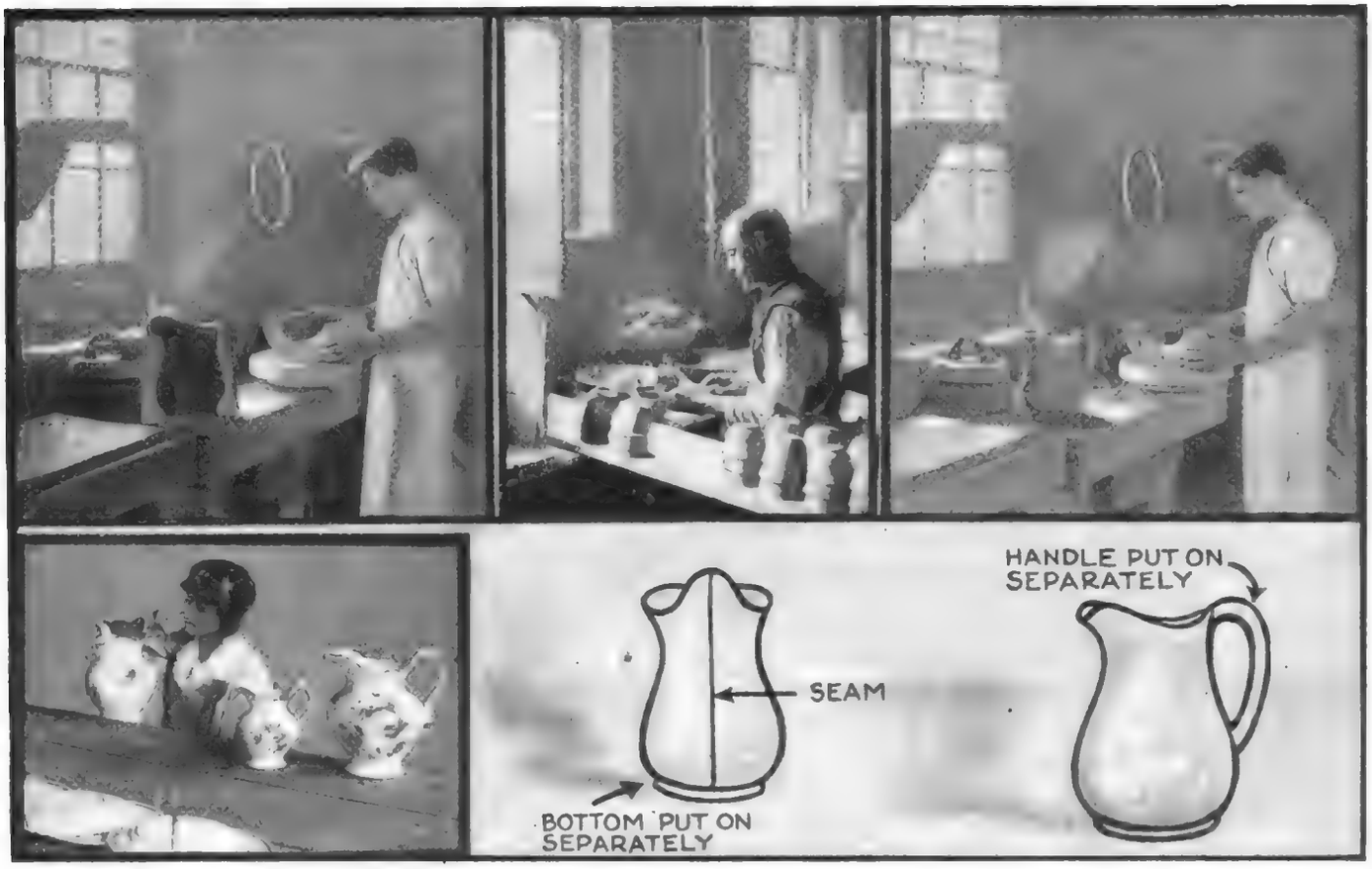

Do You Know the Various Stages Through Which Your Clay Water Pitcher Went in Its Manufacture? The Photographs from Left to Right, Beginning with the Top Row, Show the Two-Part Mold and How the Wet Clay is Molded Therein; Also How the Handles of Such Pitchers, Tea Cups, etc., Are Put on Separately, and the Ware Then Glazed and Decorated with Stencils or Otherwise, by Painting.

The Birth of a Clay Pitcher

By J. B. ELLIOTT

THE art of making general ware pottery is as old as the hills and the methods used today are practically those of centuries ago.

The main ingredient is clay, which when mixed with water forms a substance not unlike bread dough. In illustration No. 1 a potter is placing one half of a pitcher mold on his potter's wheel. Standing at the side is the other half of this pitcher mold already prepared and behind it is a batter, which the potter wil use to bat out or flatten the plastic clay into pie-crust thickness and then deftly picking up this thin layer of clay, the worker will place it over the mold on his potter's wheel, pressing the pliable substance into the shape of a half pitcher. The next operation brings the two half molds together; then they are fastened with the strap seen hanging on the wall.

The bottom of the pitcher is made in a separate mold and this is now put in place. The handle is also made separately and is attached with "slip", similar to the manner in which the "handler" in illustration No. 2 is attaching cup handles.

The top of the pitcher mold is open to conform to the shape of the mouth and this enables the potter to run his hand inside to smooth the clay seams. A little "slip" or viscous substance is also applied in this work.

In illustration No. 3 you see the the rough clay pitcher. It was made in five minutes and is now hard enough to be handled and sent to the green-room where it must dry for twenty-four hours. After coming from the green-room, the pitcher is ready for the kilns where firing hardens it and next the rough clay vessel is dipped in glaze, a pulverized mixture of sand, lead oxide, soda salts and other ingredients and water. When the glaze hardens the pitcher is ready for decorating unless it is manufactured for plain ware. The glaze has then to be fired to its melting point.

The girl in illustration No. 4 is painting a gold rim on the mouth ewer; the flowers had previously been put on with decalcomanias. The best decorated pottery is painted under the glaze; i.e. the decorations are affixed first, then glaze is flowed over them. The fact that glaze covers the floral adornment prevents it from wearing off.

Engine vs. Motor Defined

In 1916, the Society of Automotive Engineers prepared, in co-operation with engineers and representatives of service departments of automobile companies, a list of standard names for the common automobile parts in order to eliminate confusion that existed due to the promiscuous naming of parts which had developed in the early growth of the industry.

The standard nomenclature was approved by the society members and largely followed by service managers in making up parts lists. This has resulted in saving a surprising amount of time and money in the definite and prompt making and filling of orders for parts. Certain names, the use of which was recommended in the nomenclature, were, however, not adopted as generally as might be desired, probably the most important of these being the term "engine" for designating an internal combustion unit of the most prevalent type of automobile, the word "motor" being used to a certain extent instead.

"Motor" is the correct name for an electric unit used for changing electrical into mechanical energy, and its meaning as applied to internal combustion engines can be understood only by the context. An electric motor is commonly used on gasoline automobiles in connection with the starting apparatus.

The continued misuse of the word "motor" is probably due to two factors. It is used, and correctly, to designate a moving vehicle, in addition, many companies building engines were organized in the early years of the industry and included the word "motor" in their official names. As the companies prospered, the names became valuable assets and a change has been considered unwise from a business standpoint.

Nomenclature is, in a last analysis, determined by usage. Many words are common to-day which are in a derivative sense, entirely illogical, as well as entirely different in meaning from what they meant originally. "Electric motor" and not "electric engine" is, of course, the name for the electric unit; and the term "steam motor" is not used as applying to a prime-mover. "Engine trucks" and "engine vehicles" would be equally anomalous.

There seems to be little doubt of the logic and consistency of the use of the word "engine" to denote the internal-combustion or "gas" unit of motor vehicles.

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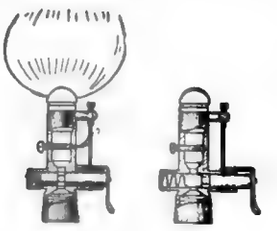
Novelties at the Inventors' Show

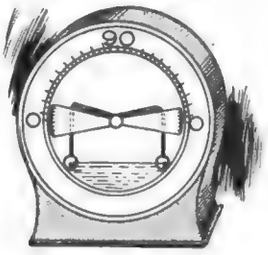
5-Artifical Hand

7-Window Cleaning Seat

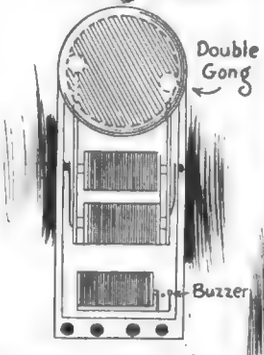
1-Sanitary Mustard Pot



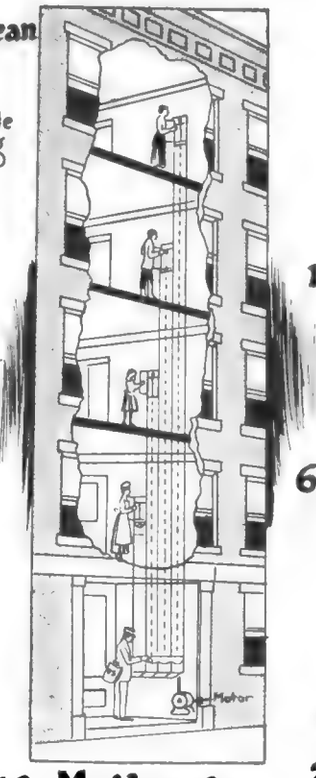
17-Safety Gas Cock



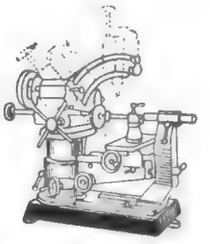
13-Anglemeter



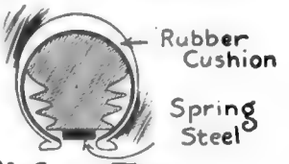
15-3 in 1 Bell



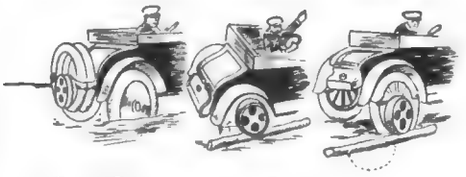
10-Mailevator



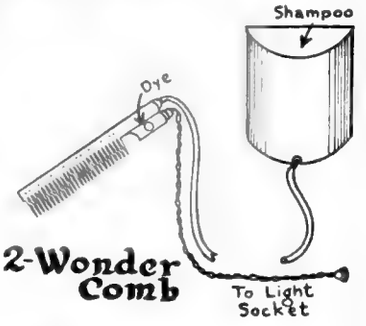
18-Triplex Lathe



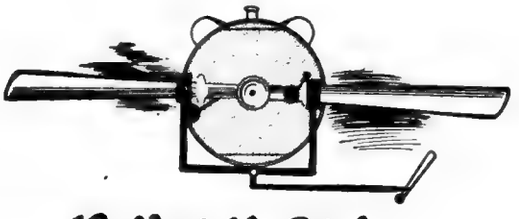
6-Airless Tire



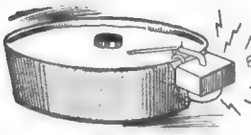
9-Rotary Jack



2-Wonder Comb



12-Variable Pitch Air Propeller



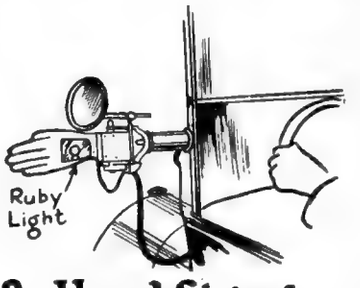
16-Overflow Alarm

14-Receiver Holder

3-Stirrup for Spring

4-Fan Attachment

11-Label Paster



8-Hand Signal

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At the New York Inventors' Show

IN this short treatise we will not, by any means, attempt to detail, nor record all of the inventions which occupied space in the *International Exhibition of Inventions and Investments* held at the Grand Central Palace in New York City recently. Some of the inventions here found have already claimed our attention in past issues of this magazine, and for that reason we will not list them again. Neither do we mean to imply that those devices, which we have omitted, are not worthy of consideration. As a matter of fact, some of them would be worthy of featuring in longer articles.

One exhibitor presented a sanitary mustard container shown in Fig. 1, which no doubt is superior to any mustard pot on the market. It is a cylindrical container in which a plunger slides, fitted at its lower end with a soft rubber washer, and provided with a grip for the fingers. The plunger itself is provided with a hollow channel, through which the mustard passes on pressing the plunger downward. It is evident that the mustard cannot harden, it preserves its odor and flavor, it does not discolor, and the method applied in this invention is free from the old-time smeariness incident to the ways of the former style of mustard pots.

William Chapman featured a wonder comb. This comb made of aluminum is provided with a heating coil, electrically operated. From a somewhat elevated tank on the wall shampooing liquids may be passed into the comb to make their way through the comb proper and through orifices in its back to the hair. Another row of orifices serves for the distribution of dye or tonic, held under pressure within the hollow handle. The comb can likewise be used directly for drying the hair, due to the heat developed, Fig. 2.

Harry Bishop demonstrated a stirrup for coil springs, which will do away with bending the spring into the form of a hook or coiling it in such a manner that it will develop a suitable security in the form of an eyelet. The stirrup can be immediately attached to a broken spring. It is shown in Fig. 3.

If you want to enjoy life a la Cleopatra, except that instead of having the slaves waft palms back and forth to cool you, you would have an automatic device fitted to your rocking chair do the work, you should purchase the device developed by Louis N. T. Guertin, Fig. 4. This is a fan attached to the back of your rocking chair, which by slight movement of the chair is caused to swing up and down. It does not create a draught, but positively cools the individual, giving him a sense of inestimable comfort. The mechanical construction is very ingenious, and the fan itself is adjustable.

A mechanical forearm and hand was demonstrated by Albert Pecorella. It is controlled from the arm. With this hand a man can saw wood, take a match out of a match box and light a cigar, drink a glass of water, holding it in the mechanical hand, carry a 75-pound satchel, pick up a pin, thread a needle, and in fact can do almost anything that the human hand can do. If covered with a glove, one would hardly believe that the individual wearing the same was carrying a mailed fist, Fig. 5.

A tire company demonstrated a tire which was made of rubber with a fabric base mounted on a high carbon steel spring band. This is placed in the outer casing the same as an inner tube. Very wonderful riding qualities and durability developed under actual test; see Fig. 6.

A seat for window-cleaning made in the form of a swing, and held in place by chains and sash-locks was of interest. This could be used for painting window frames, for cooling foods, as a guard in hanging clothes, as a platform for flowers, or as a swing for the kiddies if taken indoors. The device is shown in Fig. 7.

One concern demonstrated a mechanical hand which is attached to the windshield of the automobile, and controlled from the driver's seat. This hand is made of aluminum, with a ruby glass in the center on both back and front. The bottom is slotted, an incandescent bulb lights the device up at night. The horn is sounded whenever the position of the hand is changed. The hand can move in four directions, to the left, right, backward or ahead. Cables rotate it, see Fig. 8.

In Fig. 9 a rotary jack for vehicles is shown. This is a shell adapted to fit a tire which may be strapped to the back of the automobile. If the driver desires to carry two spares with him, he uses the individual halves of the casing for each spare. Should he sink into soft earth, he places the casing around the wheel, which has sunken and then pushes a log against the circular disk located off center. The eccentric causes the wheel to be raised. This eccentric likewise serves as a compartment for the tire tools and prevents the stealing of rides, due to the fact that it closes half of the area within the spare tires. It was patented by Faustino B. Urbano.

An elevator to deliver mail to your apartment in large buildings, was exhibited. This mailevator, Fig. 10, eliminates the old-fashioned letter box with its slot. The postman opens the mailevator door with his key, removes any outgoing mail and deposits incoming mail. As soon as he closes the door, a bell in the receiver's apartment rings, and he goes to a little cabinet in the wall and removes the mail therefrom. The device is operated by an electric motor, the circuit to which is closed when the mail door in the vestibule panel is closed. Opening the mail door in the apartment reverses connections to the motor, and (when the door is shut) sends the elevator down for more mail or carries with it the outgoing letters.

L. Casper demonstrated a machine for pasting labels on packages. This comprised a roller which applies glue or water to the back of a label, presses it against the package and makes it adhere firmly. It is a very simple contrivance, promising to be extremely popular. See Fig. 11.

A variable pitch airplane propeller, one of the cleverest designed up to the present time, was demonstrated by W. R. Turnbull. This is shown in Fig. 12. This propeller was tried out on a 230 H.P. B. R. 2 engine, running at a speed of 1325 revolutions per minute. The blades are attached to worm gears at the hub, where a wheel projects. This is struck repeatedly by a friction cushion as the propeller rotates, causing in this manner a change of pitch in propeller blades, due to rotation of the worm. The device was tried at Camp Borden, headquarters of the Canadian Air Force with great success the inventor claims.

In Fig. 13 we see the anglemeter placed on exhibition by William Richter. This consisted of a circular disc calibrated in degrees and minutes, and a rocking sector held level by two floats, buoyed up by a liquid. The degrees of inclination of the surface could be ascertained directly.

Charles Stanzel exhibited the telephone bracket illustrated in Fig. 14. By pushing the receiver toward the mouth-piece the hook is automatically depressed, cutting off the service.

Instead of using three bells, one for the hall, one for the door, and one for the dumbwaiter, one genius has combined all three into one unit. The electro-magnet in the bell, instead of being of the horseshoe shape, is provided with a vibrating arm at either end. Each of these causes a striker to hit its respective gong. A buzzer is also contained within the case, making one unit serve three purposes. There are four binding posts on its exterior, for connections. See Fig. 15.

In Fig. 16 we see the over-flow alarm demonstrated by Harry Gessler. This alarm is attached to any type of waste water receptacle such as the drip pan for ice-boxes. It is adjustable, consequently when the water rises to a certain predetermined level, the

(*Continued on page* 90)

10 Years of Science and Invention

With this issue, SCIENCE AND INVENTION starts its eleventh year. The first issue of the magazine, then called ELECTRICAL EXPERIMENTER, had sixteen pages and sold for five cents. Of that issue we printed three thousand copies.

This issue contains one hundred and four pages and cover, sells for twenty-five cents, one hundred and sixty thousand copies being distributed.

It looks as though we have been able to interest a sufficient number of readers to have this large following.

But we are not at all satisfied. We must do much better, and the editors pledge themselves to better the magazine month by month, the same as they have done in the past.

We are trying to make SCIENCE AND INVENTION the best magazine on science and invention that is published, not only in America, but anywhere. For the coming year we have in mind particularly to show inventors and would-be inventors how they can cash in on their ideas.

We are starting off with that idea this month, and we are certain that the coming issues will be of tremendous interest to all of our readers.

The publishers, on the eleventh birthday of SCIENCE AND INVENTION, desire to thank their readers for their continued support.

June Feature Articles in Science and Invention

The Scientific Tools of the Modern Detective. By Feri Felix Weiss.

Einstein Theory Explained in New Movie—Popularly Illustrated Article.

Photographing the Tracks and the Collisions of Atoms. By William D. Harkins, Professor of Physical Chemistry, University of Chicago.

New French Colored Movie Process.

The Dawn of Creation Shown in Movies.

The Difference Between Mica and Isinglass. By Ismar Ginsberg.

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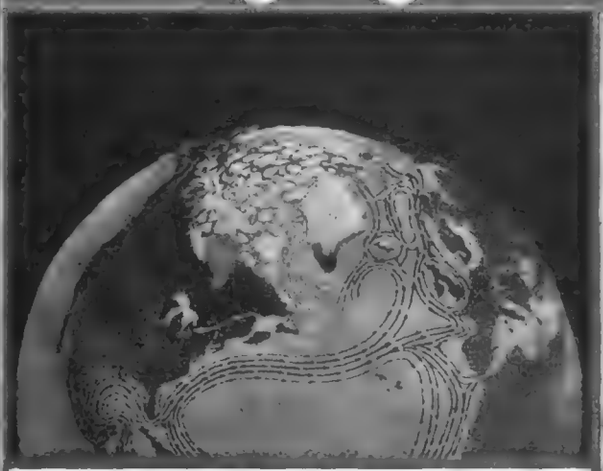
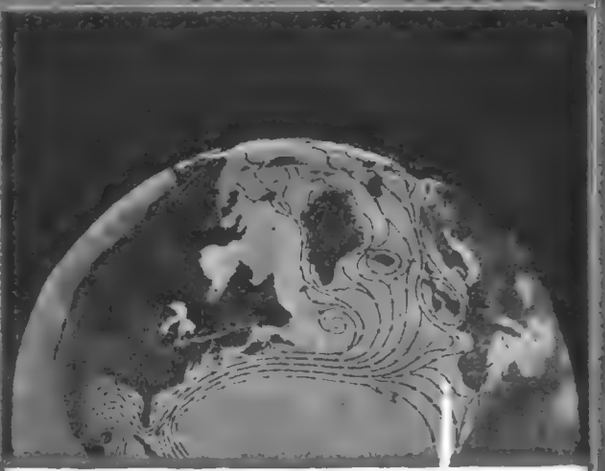
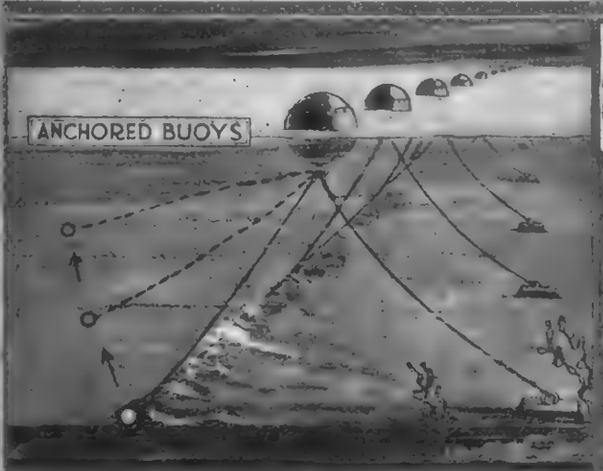
Changing the Gulf Stream



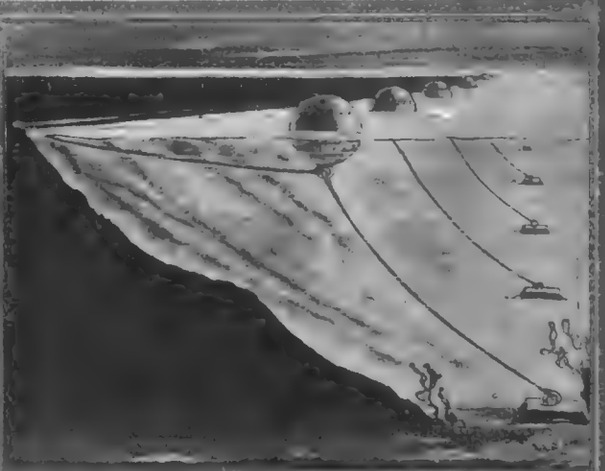
What Would Happen in Various Parts of the World, Particularly New York City, and the Atlantic Seaboard if the Gulf Stream Could Be Changed in Its Course, so as to Follow Along the Atlantic Coast and Not Dart Northeastward Toward Europe Shortly After Leaving Florida is Shown in a New Film Story. The White Arrows Indicate the Path of the Cold Labrador Currents: the Black Arrows, the Gulf Stream.



This Picture Shows a Later Stage in the Story of Changing the Gulf Stream, the New Paths of This Warm Current Close to the Atlantic Seaboard Including Newfoundland, Being Shown by the Black Arrows and the Modified, Southerly Proceeding Labrador Cold Current by the White Arrows. It is Proposed to Deflect the Labrador Current by Means of a Long Baffle Wall or Dam.



This Picture Shows Three Different Positions of the Flexible Mesh-Like Dam Supported in Position by Anchor Buoys. The Upward Movement of the Mesh-Like Curtain Takes Place, Due to the Constant Movement of the Ocean Currents, Silt and Mud Washing In and Catching in the Dam.



The Action of the Silt and Mud Carried Forward and Caused to Form a Dam or Wall in Connection with the Mesh Curtain, is Shown Progressively in the "Movie" and Finally the Completed Dam or Baffle Wall is Seen. The Ocean Depth at Various Points About Newfoundland Where This Wall Would Have to be Constructed, Are Shown in the Film Story.

View of the Hotel Plaza and Entrance to Central Park, New York City, as it is at Present. According to the Theory Set Forth in this New Film Story, and Which Has the Sympathy of a Great Many Scientists, if We Could Change the Course of the Gulf [illegible], We Would Do Away with the Severe Winters.

Here is a View of the Hotel Plaza and the Entrance to Central Park as it Would Appear if the Gulf Stream Could Be Changed. Monkeys Would Climb Cocoanut Trees Along Broadway, and Bananas and Oranges Would Be Had for the Asking, if This Great Dream Came True.

Photos from Bray Productions.

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New York Tropical With Changed Gulf Stream

A NOVEL conception in motion picture stories has recently been filmed and shown in several New York theaters. This film, entitled "Gambling With the Gulf Stream," is not only entertaining but highly educational as well. In the first part of the film the paths followed by the warm Gulf Stream as it passes northward and northeastward of the Atlantic Coast, and also the direction taken by the Labrador cold water currents, are clearly and vividly shown, by means of arrows which constantly move in a circulatory fashion. Some meteorologists today claim that the Gulf Stream has nothing whatever to do with the climate of England or Europe in general, and that it likewise has nothing to do with the relatively colder climate experienced in New York and other northern cities on the Atlantic Coast. Their theory is that the freakish weather conditions met with on the eastern coast of the United States are due wholly to changes in the barometric pressure, or in other words, to changes in density or movement of air currents across the country. One writer on the subject mentions that it is about time that what he calls the "Gulf Stream Fallacy" was eliminated from our school text books. Howsomever and be that as it may, the Gulf Stream hypothesis still has many adherents, and this new film story proceeds apace with this hypothesis for a basis.

The cinema story clearly shows in a startling manner how England is apparently warmed by the heat carried in the Gulf stream, as it wends its way across the Atlantic and finally reaches the British Isles, in spite of the fact that England is located in a latitude corresponding to that of cold bleak Labrador. In view of these facts, there was some years ago a bill presented before Congress calling for an appropriation to erect a dam off the coast of Labrador to deflect the northern water current, and possibly cause it to describe a circular course eastward toward England and simultaneously by thus deflecting this cold water current, which now bucks the warm Gulf Stream and deflects eastward just after it passes the Carolina's or thereabouts, will permit the Gulf Stream to surge northward close to the Atlantic Coast, with the result that before we knew it, we would be chasing monkeys and picking cocoanuts off palm trees in little old New York. If this change should take place, the English people would probably be glad to wear overcoats all the year round. So the accompanying pictures show the remarkable and delightful change in the scenery about the famous Hotel Plaza in New York and the entrance to Central Park "before and after taking a dose of Mr. Bray's elixir." This represents a clever piece of motion picture studio photography in itself, as the reader will no doubt admit, especially after he has seen this film story. A close-up view of the earth in relief with moving arrows reproducing the direction of the Labrador Stream and the Gulf Stream, shows in a striking manner the results to be anticipated, if this scientific experiment proves successful. If it does succeed eventually the Gulf Stream will follow the Atlantic Coast of the United States closely, and then will spread out over the north Atlantic, the warm Gulf Stream waters passing up and around Iceland and Greenland. In the film pictures you see before your eyes the ice-covered colder regions as well as those in northern Canada disappearing, and the ground itself comes into view, the effect of the Labrador currents being neutralized in this way.

The scheme proposed for attempting to deflect the southerly streaming Labrador ocean current, is elaborately illustrated in the film story, the dam required, according to its sponsors, being several miles long. It is of flexible construction, held in position in the first place by a series of large anchored buoys, as illustrated herewith. The action of this flexible dam is then shown in a realistic manner, and if it worked as perfectly as the film artist has portrayed it, it would seem as easy as eating a piece of pie. The flexible dam in the form of a great net fastened to a long cable, to which the buoy cables also attach, is carried upward by the action of the tide or current, and it is gradually filled in with sand and rock. As the flexible net member rises, the silt piles up, and eventually a perfect barrier results, as the pictures show. The redirected courses of the Labrador cold water currents and the new course of the Gulf Stream, is shown in the picture by means of the moving arrow diagrams, while sectional views show the depth of the ocean's bottom in the spot where the dam or baffle wall would have to be constructed.

Edison's Birthplace

One of Thomas A. Edison's Most Prized Possessions is This House near Milan, Ohio, Where the World's Greatest Inventor Was Born Just Seventy-six Years Ago. Photo by Mr. Waye.

Remarkable Photos of Venus Passing Behind the Moon

Early risers in the eastern and middle sections of the United States on the morning of January 13th were treated to one of the prettiest sights the heavens can afford—Venus, the morning star, playing hide and seek with the crescent moon. The beautiful spectacle lasted from 4:00 o'clock, when the moon first appeared above the horizon, until well after eight. At 6:40, the planet was so close to the moon that it was almost impossible to distinguish it. The actual contact, however, did not come until five minutes later. Then about 7:20, a tiny diamond appeared on the dark side of the moon. Venus had emerged.

An occultation of Venus by the moon is not such a rare phenomenon for the earth as a whole, but for any one place is extremely rare. For instance, there has not been one visible here since early in December, 1877, forty-five years ago.

Herewith is a series of photographs made by Mr. William Henry, of the occultation of Venus on January 13th. Mr. Henry states:

"The morning of the 13th was very clear in Brooklyn, and the sight was gorgeous.

"Besides making the photos, I also observed with my 5-inch Clark telescope. While observing the contact of Venus with the moon I was rather puzzled to see the image outlined quite distinctly against the yellow disk of the moon. Possibly this was caused by the atmosphere of Venus."

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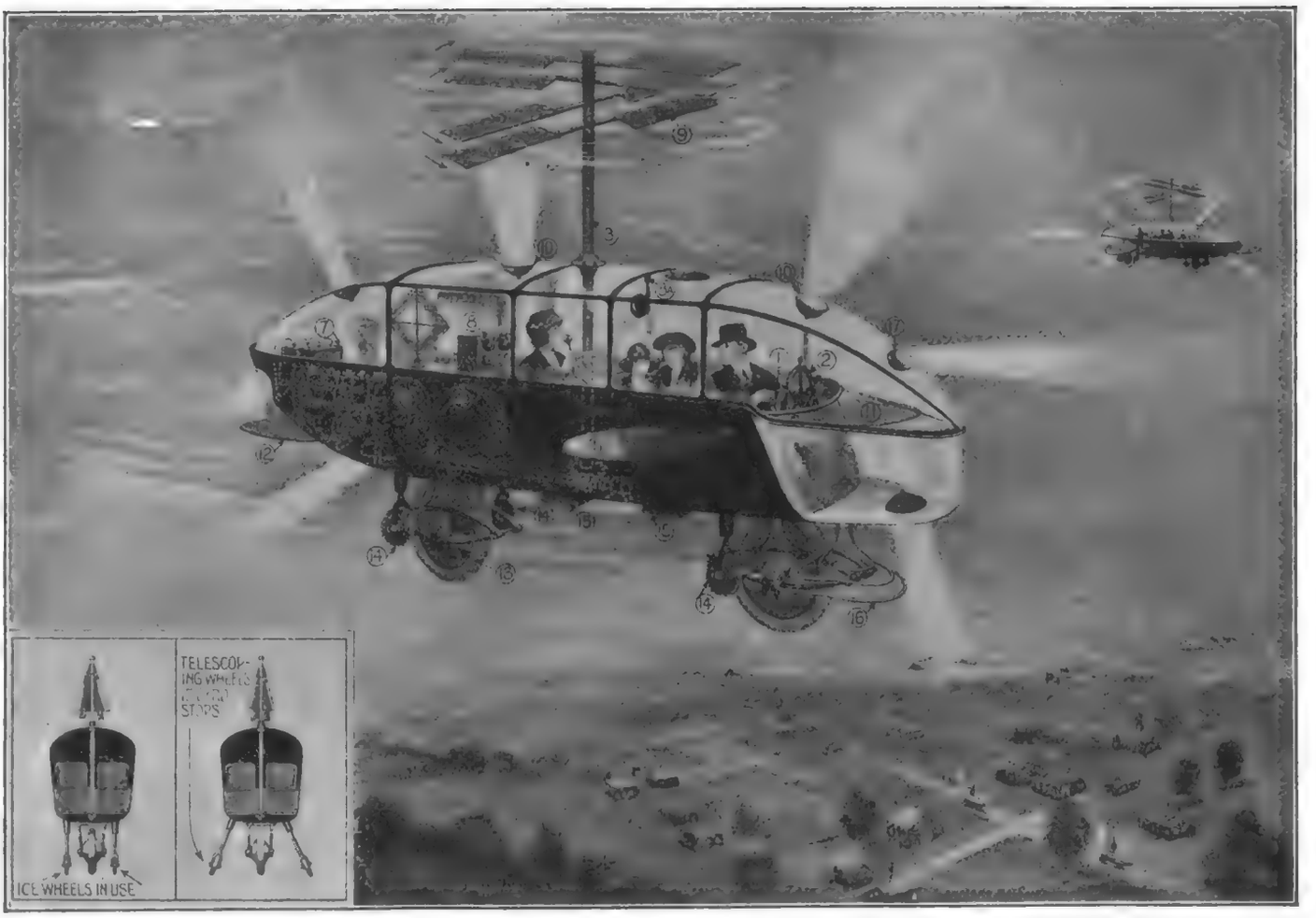

THE "HELICAR" OF TOMORROW—IT FLIES OR TRAVELS ON ROAD

1—Push Button Power Control Board Before Driver, Which Also Switches Power to Helicopter Drive Shaft 3, and Blades 9, When it is Desired to Fly.
2—Steering Wheel.
3—Helicopter Drive Shaft.
4—Gyroscope for Stabilizing Car on Two Wheels.
5—Twelve Cylinder Gasoline Engine Driving Large Dynamo 6, Which Supplies Electric Current to Motor Within Rear Wheel, 13.
7—Storage Battery for Engine and Radio Receiving and Transmitting Set, 8.
9—Collapsible Helicopter Blades. (Note: Engine Driven.)
10—Powerful Electric Lamps and Reflectors for Flying Purposes.
11—Elevating Wings Controlled by Driver, Used in Ascending or Descending, as Well as Tail, 12.
13—Electric Motor Wheel Which Drives Car Along Road.
14—Motor Driven Spur Wheels Which Can Be Lowered to Assist in Propelling the Car Out of Icy Spots.
15—Collapsible Steps.
16—Fender.
17—Electric Headlight Used When Running on Road.

The Automobile of 1973

By H. GERNSBACK

MEMBER OF THE AMERICAN PHYSICAL SOCIETY

THE modern automobile, as far as the public is concerned, is only about 25 years old. It is true that a few cars were made as much as 30 years ago, but these were not for universal use, and only millionaires could afford them. The first cars were very crude, and were not at all reliable, and when we look back upon these high-wheeled two-seaters we smile at the contraptions that they were.

The other day an automobile of that early vintage rolled down Broadway. It was running under its own power, but the sight was so ludicrous that it stopped all traffic, and every one had a good laugh at this piece of ancient mechanism.

25 short years were enough to produce this result. What, then, may we expect to see 50 years hence? What sort of automobile will we ride in? What will be commonplace 50 years hence?

The automobile, as it is built now, tends to become larger and larger. The car of today is fully three times as large as the car of 25 years ago. In our large cities overcrowding, due to the tremendous number of automobiles, has now reached the saturation point. New York City is about to enact a law to eliminate a certain number of taxicabs, which now crowd the streets to such an extent that it is impossible to make any time at all in certain sections of the city. If you really wish to move rapidly, you have to take the subway or the elevated railway. This condition exists in most large cities. It has been proposed to build viaducts over the house tops, but due to the high cost it is doubtful if such a plan will ever become a fact, even in a time remote from now.

The only practical solution is to combine the automobile with an airplane and this no doubt will happen during the next few decades. The Helicopter Automobile or, for short, the *helicar,* will not take up very much more room than the present large 7-passenger automobile, nor will it weigh much more than our present-day car, but instead of rolling down the avenue, you will go straight up in the air, and follow the air traffic lines, then descend at any place you wish. This descent can be made in the middle of the street, if necessary. The car may roll through the street, and may rise in an open place, or square, of which there will be many in the future.

While it will be possible for a car to alight on the ground in a narrow street, traffic regulations may prohibit this, and the aerial ascent and descent will be made from these public squares or parks. The Helicar will be particularly useful for suburbanites to fly to and from work, and for pleasure. Even today our roads, whether they be suburban or country, are so clogged with traffic that it is impossible to get anywhere on time.

Our front cover illustration shows the Helicar moving through one of our future streets, as an automobile, while the illustration on this page shows the Helicar as a flying machine.

It will be noted that only two wheels are used. Two wheels are more economical than four. There is less trouble with gears and shafts, and this construction decreases the weight of the car as well. A gyroscope keeps the car in an upright position at all times, and makes riding on two wheels perfectly safe.

Two-wheel vehicles are not new, as witness the bicycle. The famous Englishman, Brennan, has already tried them out, and there will be no reason for using four wheels in the future.

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In case ice or very slippery streets are encountered, the small side wheels, illustrated on either side of the large traction wheels, can be lowered instantly, and will keep the car from falling over.

Then there is the second idea as shown in the insert of our large illustration, where we see the telescoping wheels, which can be used for the same purpose; these are also useful if, by chance, the gyroscope stops operating, or when the car stands in the garage. These side wheels would then keep the car from tilting over. These little telescoping wheels are placed at the end of a cylinder, and compressed air drives them out by a piston, until they make contact with the floor or ground, there to uphold the car. These are simple details that any engineer, even today, can work out.

The important part is the propelling mechanism to drive the car in the air. There have been many helicopters designed so far, but up to date nothing really trustworthy has been evolved. It may be quite possible that the helicopter of the future will look entirely different from what we have pictured in our illustration. It is quite possible that no blades will be used, but rather a form of an open drum, similar to the turbine. We have been satisfied to show in our illustration the usual propeller, which is collapsible, so that when the car runs as an automobile, it will not obstruct traffic, nor will it catch the air. Some such plan must be evolved for the Helicar of the future. By tilting the elevating wings shown marked "11" in our large drawing, as well as the tail "12," the car can either ascend or descend at any desired level, all of which is controlled by the driver. The wings, as well as the tail, can be made collapsible also, so they will not extend outwards when the car runs on land. The Helicar of the future will not have any complicated steering wheel, and many levers, as in our present cars. Instead there will be a sort of push-button power control board, located immediately in front of the driver, which will also switch power to the helicopter drive shaft "3," and the blades of the helicopter "9," when it is desired to fly the car.

The Fine Motor Car of Today is Well Typified in the Rolls-Royce Sedan Model Here Illustrated. Every Convenience is Provided for the Passengers. It Sells for About $13,000 and Its Powerful Engine, Rated at 48.6 H.P., But Developing About 100 H.P. When Necessary, Propells This Parlor on Wheels Along Level Road or Mountain Grade with Equal Ease and Smoothness.

An emergency steering wheel "2" may or may not be used. Probably the entire car will be operated from a small push-button switchboard. It is quite possible that the car of the future will be driven entirely by electricity. We have shown in our large illustration the gasoline engine and dynamo plant, such as will possibly be used in the Helicars of 1973; the rear or both wheels being propelled entirely by electricity (electric motors are enclosed within the wheels like those used on some trucks to-day) or perhaps some other form of power, of which we know nothing today. It goes without saying that the car will be built of the lightest materials, and it is quite possible that the future flying car will weigh far less than our present-day cars. The entire upper part of the body will be enclosed in an unbreakable, unburnable, glass-like substance. This is quite necessary, particularly for the driver or pilot who must not only be able to see on all sides, but up and down as well, in order to avoid collisions. There will also be various signal lights for night-flying. The front and rear downward lights will probably be green, the front and back upward lights will probably be red. For city use, running on the road, the usual lights will be used. In other words, there will be two sets of signal lights, one set for flying, the other set for the road. It also goes without saying that these cars will be equipped with Radio, both for sending and for receiving. It will be possible for every one to talk to and from this car over a radius of hundreds of miles. Radio will be quite an important feature of such a car, particularly as the Helicar will depend a great deal upon the weather—and storm warnings can be broadcasted from a number of meteorological stations, so that every one in the air can be apprised of danger.

However complicated this Helicar will appear, it will not cost very much more than a present-day up-to-date first-class automobile.

It is even quite possible that the Helicar of the future will be equipped with propellers, or fins in the propelling wheels, so that the car can descend and move upon the water if this is desired.

In our illustration we have shown a gasoline engine as the driving agent for the Helicar. There is no reason why a gasoline engine should be employed. Perhaps by that time we will be extracting electricity from the air, and merely use an electric motor to run the car, or we may even approach the point where the wireless transmission of energy will be a proven fact. We would, of course, have to equip our cars with a fender, and motor driven spur wheels for use on icy roads where traction from the rubber tires would be insufficient for locomotion. Steps which fold out of the way when all the occupants are within the car will reduce the air resistance of this type of vehicle.

The First Auto: Exhibited at the Smithsonian Institution, Washington, D. C., is America's First Car, Invented, Designed, and Built by Elwood Haynes, President of The Haynes Automobile Company, Kokomo, Ind., in 1893. The Car Shown Above in Which Mr. Haynes is Seated is Now Owned by the United States Government. The Exhibit at Washington Bears the Number 262,135.

Smoking Beneficial, Says Paris Savant

DR. E. P. ROGER of Paris has carried out a series of experiments of which the result should cause much rejoicing among smokers.

According to this authority, my lady nicotine isn't so dangerous as we hitherto have been given to understand. Having taken ten grammes of ordinary French caporal tobacco, Dr. Roger extracted all the nicotine, producing a liquid which was sufficiently poisonous to kill a dog weighing sixty pounds. The doctor then took ten grammes of the same tobacco and incinerated it under conditions similar to that of a pipe, producing a liquid which contained not only nicotine, but all the other chemical substances contained in tobacco. This liquid did not kill a guinea pig weighing two pounds and produced no effect whatsoever on the intestines of a dog weighing sixty pounds.

The reasons are said to be that incineration transforms the nicotine and turns the greater part of its poisonous substances into a chemical which is not dangerous, although possibly slightly irritating, such as cresols, phenol, pyridine, etc. These substances, according to the theories of Professors Moureu and Bufraisse, all possess anti-oxygenous qualities and may prove helpful to prevent the development of microbes requiring oxygen in order to multiply. Thus, smoking moderately, far from being unhealthy, should act beneficiently on the health.

In the case of certain epidemics smokers rarely suffer. Cerebro-spinal meningitis, for instance, very rarely attacks smokers.

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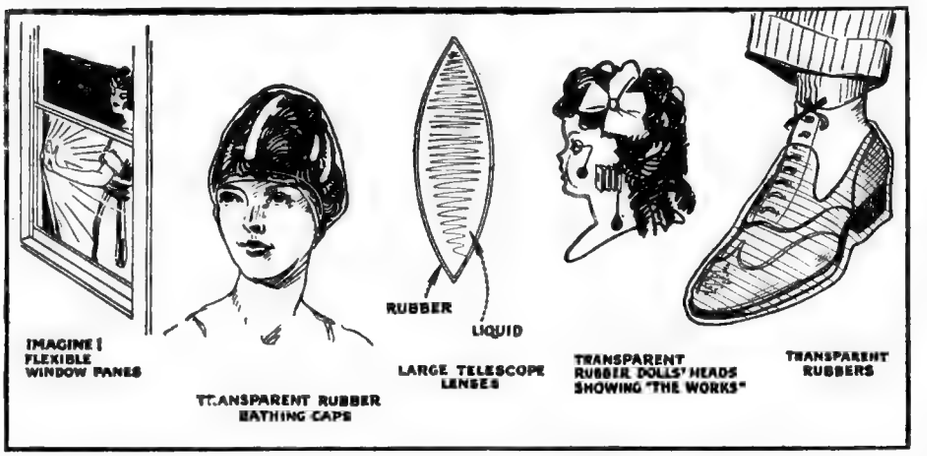
Rubber as Transparent as Glass

By ISMAR GINSBERG

RUBBER is the coagulated sap of a tree. These trees grow wild in the tropical regions of South America, which is the source of supply of Para rubber. Natives cut gashes into the bark, hang pails below to catch the sap as it oozes out, collect the sap and cause the liquid rubber, the latex, to coagulate on sticks by subjecting it to the acrid action of the smoke obtained by burning the leaves and twigs of the rubber tree. Up to a recent period this constituted the sole source of supply of rubber.

To-day we also have plantation rubber as well as wild rubber. Plantation rubber comes from the plantations in Ceylon, where the rubber trees are grown under accurately controlled conditions and the coagulation of the latex is conducted in a scientific manner. The product, which comes in the shape of sheets, known as plantation crepe, is light yellow in color, while the wild rubber, which comes in the form of balls, is colored dark brown.

The idea of taking all the color out of rubber and obtaining a product as transparent as glass is of English origin. Special bleaching methods have been devised to bring this about, but the exact nature of the methods has not been disclosed. Inasmuch as rubber is filled with all sorts of substances in order to give it weight and increase its strength, special care will also have to be taken in the selection of these substances.



Now That We Are Able to Produce Rubber Which is as Transparent as Glass, Many Uses For it Can Be Found. In the Illustration Above We Find This Material Applied to Window Panes, Bathing Caps, Telescopic Lenses, Dolls' Heads, and Overshoes.

Our interest lies in the possible applications of transparent rubber. The transparent rubber could be either soft or hard. Imagine a rubber window pane. It would appear just like glass but could be pushed out with the hand. It would be unbreakable and would eliminate all danger from broken glass. The insurance companies would welcome it as a boon. There would be no need for plate glass insurance. The windows of our houses, in factories, office buildings, in automobiles, cars, trains, conveyances of all sorts, could be made of this product. Rubber window panes would not break in collisions, or at best if they did there would be no danger of flying glass. The very fact that it would be unbreakable would render it available for use for various new purposes and in places where, while it is now desired to use glass, nevertheless glass cannot be employed, because of its tendency to break.

The question arises as to how the India rubber "glass" will stand the effects of sunlight, for light has a deleterious effect on rubber, and in time rubber is decomposed by light. It may be possible to coat the rubber glass with a transparent collodion or cellulose acetate in a thin film,

(*Continued on page* 94)

Transplanting Insect Heads

By RUDOLPH ADOLPH

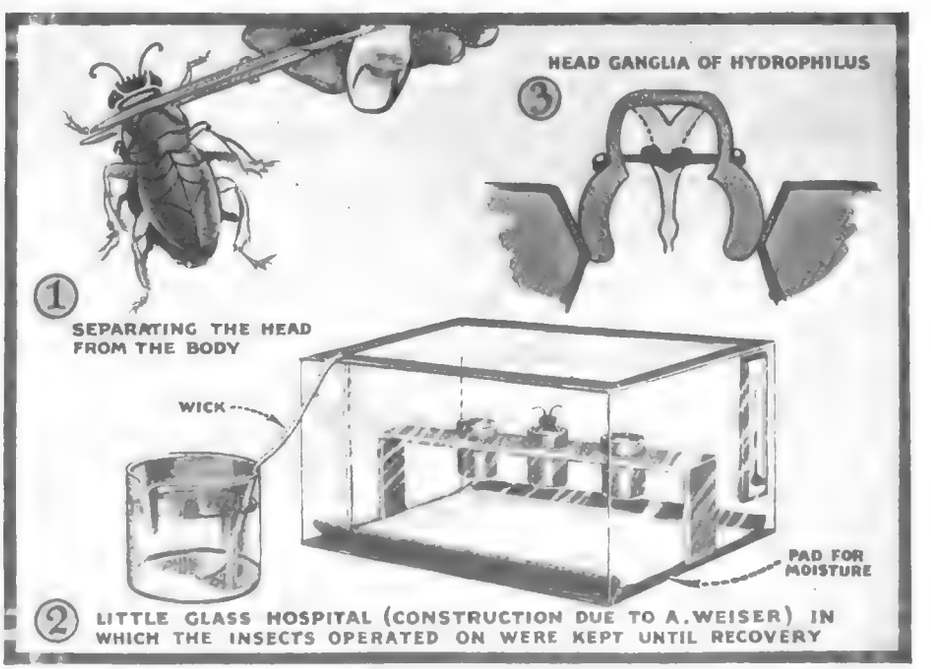
OF THE HERPETOLOGICAL STATION, OLMUTZ, AUSTRIA

IN the Akademischer Anzeiger, No. 18, Vienna, 1921, there is an article by Walter Finkler on "Grafting the Heads of Insects." Although the results of these experiments are extremely interesting, I have observed that the labors of this savant are unknown even to brother scientists in Germany.

The method of the experiments is thus described by Finkler: "The head is raised from the socket of the thorax, and is separated from the body by a scissors cut, and transferred to another insect which has been treated in the same way. The outer edges of the wound are closed, the blood escaping in a very small amount, due to narcosis, and the head is in the condition for a very favorable healing. Stitches and other extraneous bonds can be dispensed with."

Dr. Finkler carried out with success the transplantation on various insects on the *imago* of water beetles and swimming beetles, on the larva, and on the pupa of the *ephemera vanessa yo* and *urticae*. Next he investigated the relations of the beheaded insects, so as to ascertain the capacity of the transplanted heads for carrying out their proper function. I quote from Finkler's paper: "A beheaded water beetle can carry out any co-ordinated movements, but cannot steer a straight course either in the water or on land. The movements of a beheaded grasshopper are distinctly different from those of the normal insect. While normal insects with all pairs of legs go forward, the front pair of legs on the beheaded insect go always forward, the last pair of legs always go backward and the middle pair of legs serve as a support. It is evident that this curious development was caused by the shock, as the following experiment shows: Insects whose heads, with the exception of the cerebral—and the throat ganglia, have been separated, in swimming act quite normally after the operation."

(*Continued on page* 96)


HEAD GANGLIA OF HYDROPHILUS
3
1
SEPARATING THE HEAD FROM THE BODY
WICK
PAD FOR MOISTURE
2
LITTLE GLASS HOSPITAL (CONSTRUCTION DUE TO A. WEISER) IN WHICH THE INSECTS OPERATED ON WERE KEPT UNTIL RECOVERY

Insects' Heads Have Been Successfully Transplanted by a German Investigator. The Method is to Separate the Head From the Body With a Pair of Scissors, and to Substitute This on the Body of Another Insect Similarly Treated.

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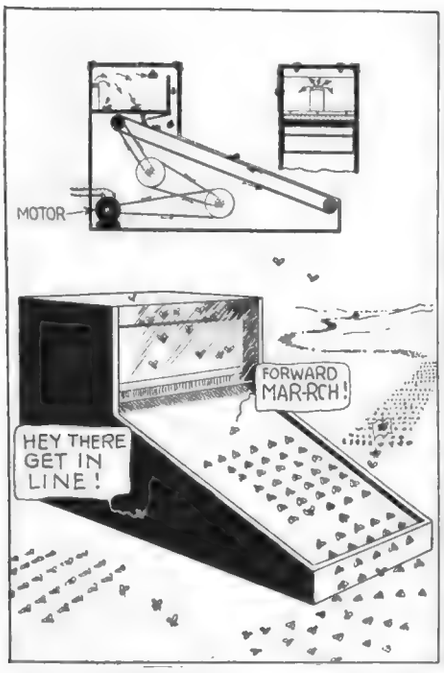

A Fly-Trap Designed by an Ambitious Inventor is Illustrated Above. The Sectional Elevation at the Top of This Illustration is Taken From the Patent and the Comic Version Shown Below. Notice the Endless Belt Used to Convey the Flies Into the Trap.

Stolen Automobiles Will Not Only Emit Musical Sounds as They Are Driven Away by the Thief, But Will Also Paint a Striped Color Band Upon the Sidewalk to Indicate the Direction in Which They Were Driven. If This Invention is Put Into Use the Detectives Will Then Trail the Machine by Following the Colored Stripe.

Why Tug at the Oars When You Can Place Your Companion on One Seat, and Locate Yourself on the Opposite Seat of a Sea-Saw, Pivoted at the Center of the Boat, and as You Rock Up and Down, the Boat is Propelled Due to the Action of the Paddle Wheels. The Result Obtained When Companions Vastly Differing in Weight Use This Vessel is Depicted by Our Artist.

Humor in the Patents

IF you find that your weekly humorous journal cannot coax a smile from you, do not despair. Obtain a copy of the Patent Office Gazette. Nearly every copy contains *real* humor, that costs the originators from $100 upwards a piece —this being the price of the average patent. For instance, we turn to a patent of a fly trap issued to Messrs. Snuffer and Shanks, and proceed to animate the patent illustration with our pencil. In this patent an endless belt conveyor positioned upon rollers, is covered with honey or syrup. This is arranged in an inclined position and driven by an electric motor. The fly is attracted to the conveyor and does not notice its upward passage, until a brush frightens it, whereupon the insect immdeiately flies upward toward the light. This flight is limited by a glass container, in which is a fumigant sufficiently powerful to kill the insects or flies as they arrive in the compartment. We place the flies in battalion array, like so many soldiers marching on the parade grounds. All the flies march to their doom, stepping on the endless conveyor, to be gently escalated to their execution chamber. We admire the thoughtfulness of the inventor in building an endless conveyor, so that the poor flies would not become footsore and weary as they trudged their way up the slope, by providing them with the moving platform. We wonder what was the predisposing cause of the inventor's thoughtfulness in feeding the insects preparatory to mercilessly snuffing their lives out. We wonder whether or not the death was pleasant and painless to the flies, and wonder if each individual fly did not have a right to be sentenced by the judge and jury, and to take appeals from such sentences, particularly in view of the fact that they had been lured to their untimely deaths.

We turn the patent specifications over still soliloquizing on heartless inventors, and pause as we come to the invention of Hans Straub. This is a vehicle thief detector. Mounted within a casing located near the back wheel is a drum fitted with a clutch, so that by driving the drum toward the wheel, it would engage with the wheel and be turned by it. This drum has a series of points projecting from its surface, which act on bells or vibrating bars. In addition to that, there are three compartments containing moist powder colored red, black and white. The containers themselves are open at the bottom, but the openings do not align themselves with similar holes in the casing until the machine is locked. Invisible signals, such as light flashes, are also employed. Should a thief run off with this machine, we would believe him to be driving a street organ as we would have music while he is *en route*. Of course, there is nothing very musical in some of the cars which we hear rattling along on the city streets, so it stands to reason that a tin organ of this nature would create quite a commotion. One or two officers might even look at it as it buzzed up Fifth Avenue, but then as the thief got away we would have our detectives looking for the car with magnifying glasses, following the trail of colored powder which the car has left behind it. If the car rambles over snow, the black powder can be seen; if it travels over dark roads, the red and white powder can be seen; and the red powder can of course be seen everywhere. It is a wonder that the inventor does not give us a colored ribbon with red, white and blue powders. This would be more patriotic, and inasmuch as automobiles would not run over the colors of the American flag, drivers would have to trail the stolen machine and then circle around it at its resting place.

We turn a few more pages and come across the boat propelling device invented by one Stanislaw Wisniewski. This has a see-saw arranged in the center of the boat, which by means of levers and cams causes a rod to move back and forth. The oscillating rod in turn operates ratchets, which in turn transmit the motion to gear trains, and thence to paddle wheels on the side of the vessel. Vessels of this nature will be perfectly balanced, because if a very stout individual and a relatively slim person sat at the ends of the see-saw, it would be impossible to rock the same. Consequently, the stout person will have to sit nearer the center of the vessel, and the see-sawing motion of the waves would help the occupants of the boat in propelling the vessel. Of course it is not advisable to rock this boat, because by doing so the balance of the person on the up side of the see-saw would be considerably unsteady, and he may lose his position on the perch, catapulting himself into the water.

Your Heart Beats Heard All Over the Room

By means of the new apparatus it is now possible for a physician to hear heart beats magnified with sledge-hammer intensity throughout a large room. Do not fail to read all about it in the May issue of PRACTICAL ELECTRICS.

Two audiences, one in Chicago, one in New York, hear and see simultaneously the proceedings that take place on the lecturing platforms in the two cities, illustrated in large wash drawing in May PRACTICAL ELECTRICS.

OTHER INTERESTING ARTICLES IN MAY PRACTICAL ELECTRICS.

The Loud Talking Heart
By Clyde J. Fitch
Chicago-New York Engineers' Symposium
Electric Drying Oven
Influenza and the Telephone
By Dr. Albert Neuburger, Berlin Correspondent, PRACTICAL ELECTRICS
Electricity and Crime
Electric Prevention of Fires

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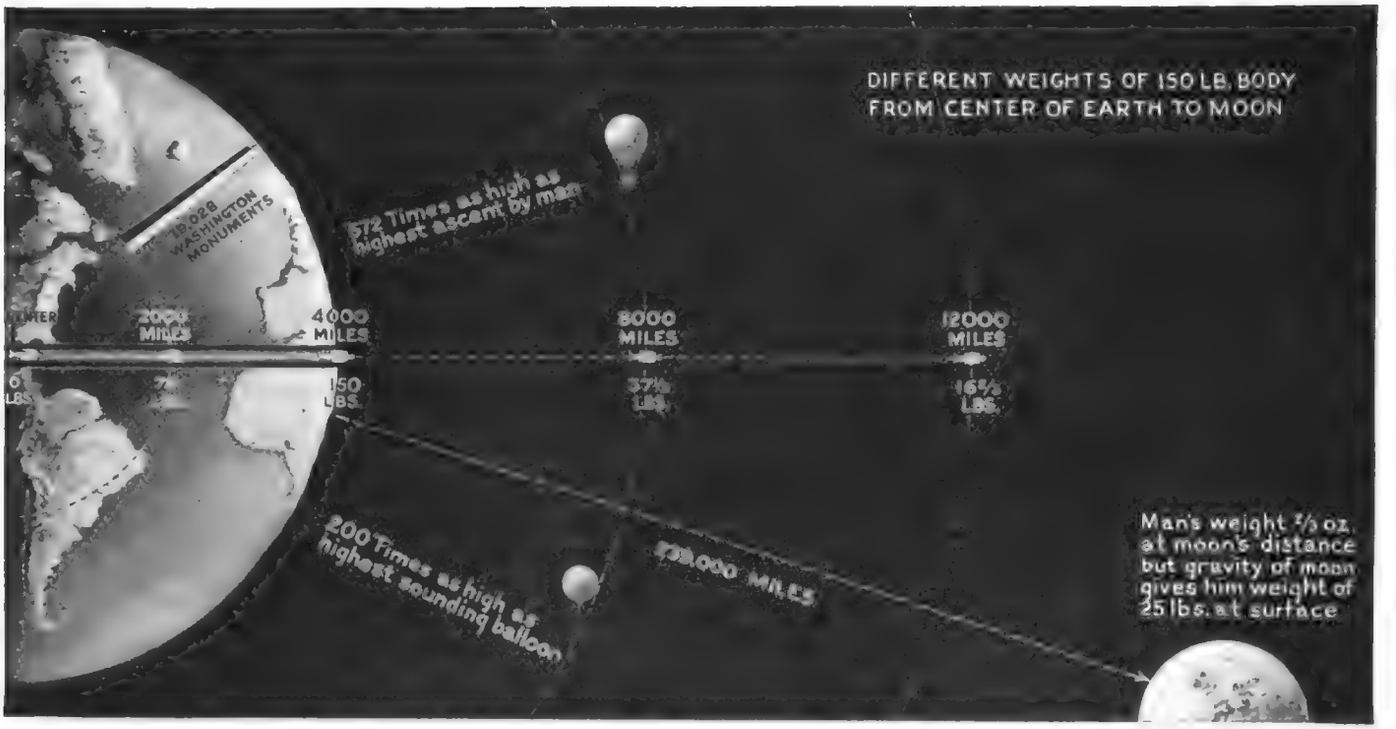
DIFFERENT WEIGHTS OF 150 LB. BODY
FROM CENTER OF EARTH TO MOON
572 Times as high as highest ascent by man
18,028 WASHINGTON MONUMENTS
2000 MILES
4000 MILES
8000 MILES
12000 MILES
150 LBS.
37½ LBS.
16⅔ LBS.
200 Times as high as highest sounding balloon
239,000 MILES
Man's weight 2/3 oz. at moon's distance but gravity of moon gives him weight of 25 lbs. at surface

In the Accompanying Picture-Diagram We Have Shown Some of the Salient Facts Brought Out in Mr. Holmes Article, with Regard to What a Man Weighs Both Above and Below the Surface of the Earth. A Body With a Given Weight at the Surface of the Earth, Weighs Less As It Moves Toward the Center of the Earth; it Also Weighs Less, but in a Different Ratio, as it Rises Above the Surface of the Earth, as the Picture Clearly Illustrates. At a Distance from the Earth Equivalent to That Extending to the Moon, a Man Will Weigh Two-Thirds of an Ounce, But Due to the Gravity of the Moon if He Should Land on It, He Would Have a Weight of 25 Pounds on its Surface.

A Journey from the Centre of the Earth

By CHARLES NEVERS HOLMES

WE are standing at the *exact* center of our Earth—at the center of a body possessing a volume which approximates 260 billion cubic miles—at the terrestrial center, about 3,959 miles from the terrestrial surface. Air at great density surrounds us,—it has a density perhaps ten times that of water. There is terrific heat on all sides of us. Nevertheless, our weight is an absolute cipher. Our body has no weight. And why should we have any weight at the *exact* center of our Earth? There all of gravitational attraction lies outside of us and pulls equally in all directions. There is not a particle of matter to pull us towards the terrestrial center, and, by so doing, to register what is known as our "weight."

Let us suppose that as though ascending an elevator-shaft, we leave our Earth's center, and rise towards the terrestrial surface. At ¼ of the distance from center to surface, what do we weigh? Now there are particles of matter to pull us back towards the terrestrial center. We have left that center about 990 miles behind us. Upon our Earth's surface, we weigh 150 pounds. Inasmuch as 990 miles are only one-fourth of 3,959 miles, we shall have a weight of one-quarter of 150 pounds,—37½ pounds.

Accordingly, when we have risen 1,980 miles, we shall be halfway to our Earth's surface, and our weight will then be one-half what it is at the terrestrial surface,—75 pounds. When we are three-quarters of the distance to the surface, we shall weigh 112½ pounds. Thus, our weight increases in proportion as we ascend from center to surface, and decreases as we descend from surface to center. That is, the weight of a body increases or decreases *directly* according to its proportional distance from the earth's center, as long as it is below our world's surface.

We reach the terrestrial surface and then regain our full weight of 150 pounds. Perhaps we do not wish to remain there, but desire to soar aloft, into space. Now, at first thought, it would seem as though the same law of weight increasing or decreasing *directly* following the law of proportional distances obtaining when below our earth's surface, would still be valid and unchanged. But such is not the case. When we begin to soar *above* the terrestrial surface, we lose in weight *inversely* according to the square of the distance from the center of our earth. That is, the distance from terrestrial center to surface, 3,959 miles, is taken as a unit, and each approximate 4,000 miles are compared with this unit. This leaves centrifugal force out of the calculation.

We leave the terrestrial surface with a velocity of about 37,000 feet per second, to break the chains of gravity, pass through 300 miles of attenuating atmosphere, and then travel swiftly through the so-called *ether* of space. Here, density is at a minimum and the temperature approaches, possibly, what is known as "absolute zero," —273 degrees, below zero (Centigrade). After we have ascended about 4,000 miles, our weight is considerably decreased. It is not difficult to estimate it, approximately. We are now about 8,000 miles above the earth's center, or twice the distance from that center to the surface. That is, our weight by the law of the inverse squares is now reduced to one-fourth of 150 pounds, or 37½ pounds.

And when we have attained an altitude of 12,000 miles, we shall be 3 times our standard 4,000 miles from the terrestrial center. Therefore, we shall have a weight of only one-ninth of 150 pounds, that is, 16⅔ pounds. And so it goes on indefinitely. Finally, we have reached a point in space whose distance equals that of our moon, at its mean distance—239,000 miles. This is about 60 times 4,000 miles, so that our weight is then only 1/3600th of what it was at the terrestrial surface. Of course, we are supposing that our earth is the only body in space, for, were there any other body near us, that body would also attract us, thus influencing our so-called "weight." Accordingly, it is evident that we may possess two kinds of weights, the first if we were between the earth's surface and its center, the other if we were on or above the terrestrial surface in space. Thus, in a journey from the center of our earth, we should commence with no weight and attain our full weight at our earth's surface. But in a journey to the moon we should lose weight during part of the way, then regain some of it as the moon began to attract us. That is to say, we who weigh 150 pounds on the terrestrial surface, should weight about 25 pounds at the lunar surface. In other words, our earth attracts bodies with six times as much force as the moon does.

Frenchman Flies 234 Miles an Hour

THE French aviator, Sadi Lecointe, broke the world's speed record on Feb. 15th by accomplishing 377.657 kilometers an hour (234.064 miles). This betters by 18.821 kilometers the record of 358.836 kilometers established last October by General William Mitchell in Michigan.

Lecointe's flight was made at Istres. near Marseilles, in a Nieuport-Delage plane carrying a 300-horsepower Hispano-Suiza motor and a Solex carburetor. The first kilometer was made in 9 1-5 seconds, or a speed of 391.304 kilometers an hour; the second in 10 seconds, or 360 kilometers an hour; the third in 9 2-5 seconds, or 382.978 kilometers an hour, and the fourth in 9 4-5 seconds, or 376.346 kilometers an hour.

Lecointe's last world's record was made Dec. 31 when he flew at the rate of 348.28 kilometers an hour.

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A New Colored Movie Process

THE production of perfect colored motion pictures is claimed by Mr. P. D. Brewster, an American inventor, who has been interested in motion picture work for several years. His experiments in colored photography have extended over a period of more than nine years, and he has at last perfected a system which he claims is as near perfect as it is possible for a colored picture to be. In a recent interview with the writer, Mr. Brewster exhibited several still views taken by essentially the same process as he uses in his moving pictures. The tones and shades of colors in these photographs were a revelation. Detail was perfect, and the colors blended into one another in a most remarkable manner.

In explaining his process Mr. Brewster explained that one of the main features was the special light-splitting combination of prisms. This device consists of two triangular prisms. On the face of one of them is a checkerboard effect composed of minute silver squares alternating with transparent squares. The two prisms are placed together face to face, so that the silvered surface, when viewed from the end of the square block thus formed, runs diagonally across it from corner to corner.

The action taking place in connection with these two prisms, may be plainly seen in the accompanying illustration. The light from the subject being photographed enters the lens, which, of course, is equipped with the usual shutter and diaphragm, and proceeds through the side of one of the prisms. When it strikes the silvered face, it is split up; that part of the light which falls upon the silvered squares being reflected at right angles to the original beam and passing through a blue-green filter, is focused upon a film which registers the intensity of the red shades of light. That part of the light which is not reflected passes on through the prisms and after passing through a red filter, gives the image upon a film which receives the picture in tones of blue-green.

Because of the fact that only one lens is used in taking these films, any stereoscopic or blurring effect is eliminated. Mr. Brewster also has done away with the difficulty usually encountered in photographing flesh tints. In the first attempts at color photography, the hands and faces of the actors were reproduced in a sickly brown shade. This new process, however, does not have this drawback, and in the photographs shown to the writer by the inventor the flesh tints were exceedingly well registered. A section of colored positive films showed very fine color values.

After the two negative films mentioned above have been exposed and developed, they are both printed simultaneously upon opposite sides of a positive film, which is sensitized on both sides. This is made possible by means of a chemical which renders the film opaque, until it is run through the developer where the chemical is eliminated. In the printing process as well as in the exposure of the negatives, the films are all kept in synchronism by means of specially designed but relatively simple apparatus, which we will not attempt to describe here.

The two sides of the positive film are treated, so that in the final process they will be color-sensitive to orange-red on one side and to blue-green on the other. The blue-green negative is exposed on the orange-red side of the positive, and the red negative on the blue-green side of the positive. The accompanying illustration shows the degree of shade obtained with two negatives as well as on the two sides of the positive, when a strip containing red, white and blue squares is photographed.

In 1, the red photographs transparent on the blue-green negative, the white very dark, and the blue semi-transparent. In 2, the red is semi-transparent, the white very dark red, and the blue transparent. When these are printed on their respective sides of the positive, the results shown in 3 and 4 are obtained. In 3, the red shows very dark orange-red, the white transparent, and the blue a medium shade of orange-red. In 4, the red comes out a medium shade of blue-green, the white transparent, and the blue a dark shade of blue-green. When these are super-imposed upon each other, the true colors will appear. This is rather hard for the layman to understand at first, but if he will take a piece of red celluloid and a piece of blue celluloid, and place them over each other, and look through the combination, he will find that the resulting color will be entirely different than either the original red or blue.

After the printing the positive goes through the developing, fixing and washing baths, and is afterwards carried to a bleaching solution which renders the emulsion susceptible to certain dyes. The sides of the film are then separately treated with certain dyes, and after drying are ready for projection.

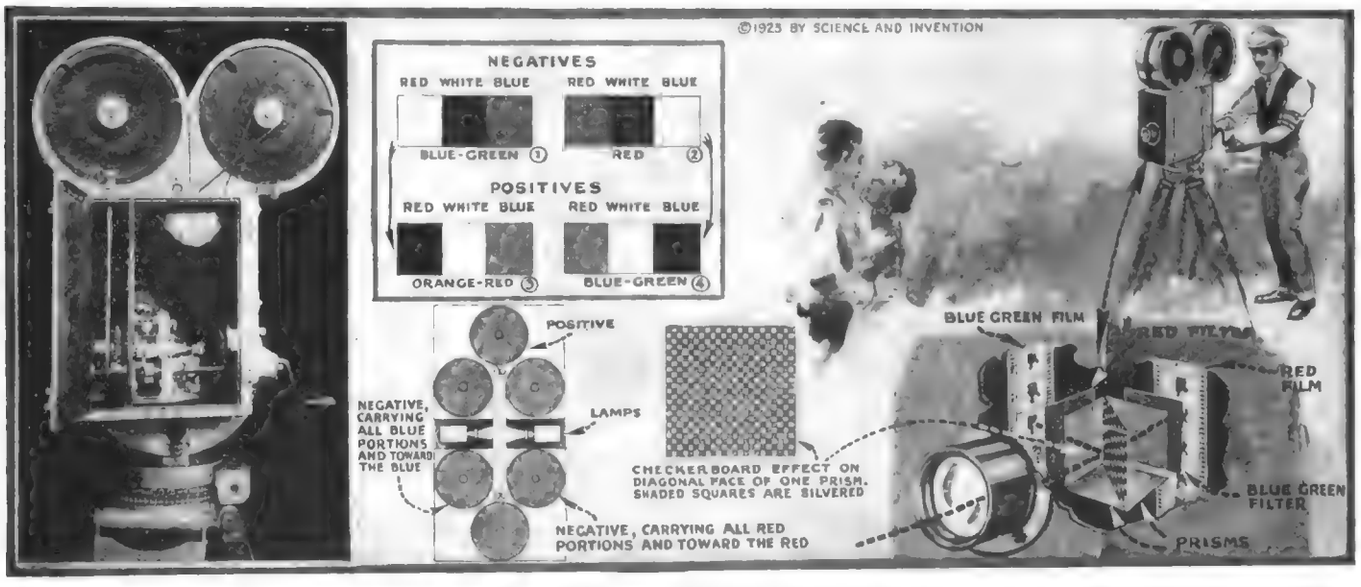
This film can be used in any standard projector without any adapters of any kind.

For various kinds of photography there are three series of negative films with corresponding positive films used. For outdoor work where foliage and bright colors are paramount, the negative films are light sensitive to blue-red and yellow. For studio work they are sensitive to red and blue-green, while for scenes where sea and sky predominate, they are orange and blue. Of course the filters used are of the color to which the film is sensitive.

Mr. Brewster at present is talking photographs with this method and is exhibiting them in a private studio in New York City. He expects, however, to have his processes developed to such an extent that his work will be commercially available in a very short time.

The many advantages of colored motion picture photography are at once obvious. The value of the more elaborate productions being shown before the public today, is sometimes seriously detracted from because of the inability of the pictures to faithfully reproduce the colors of the various parts of the sets. For instance, the writer was quite disappointed when viewing a motion picture recently which was highly exploited by the press agent. The entire production was very elaborately assembled, and some wonderful old masterpieces used in adorning the walls of various scenes. Because of the black and white reproduction, however, the color values of these pictures were lost, and the effect was not even comparable to what it would have been if some system of colored pictures were used, such as Mr. Brewster's.

This value of such colored effects in scenic productions can be very easily imagined. The difference between a standard motion picture of, for instance, the Grand Canyon of Colorado, and one of the same scene taken in colored movies is almost unbelievable.



The Left-Hand Photograph Shows an Interior View of the Camera Used in Taking the Brewster Colored Movies. The Four Figures in the Upper Center Show Diagrammatically How Various Colors Photograph on Both the Positive and Negative Films. Directly Below This is Shown the Method of Printing the Positive Film from the Two Negatives. In the Lower Right Hand Corner Will Be Seen a Diagrammatical View of the Camera Used in This Process. Standard Motion Picture Films Are Used and the Light is Filtered Through the Color Filters Shown. The Film in Back of the Blue Green Filter Registers the Red Color Values, and That in Back of the Red Filter Registers the Blue-Green Color Values.

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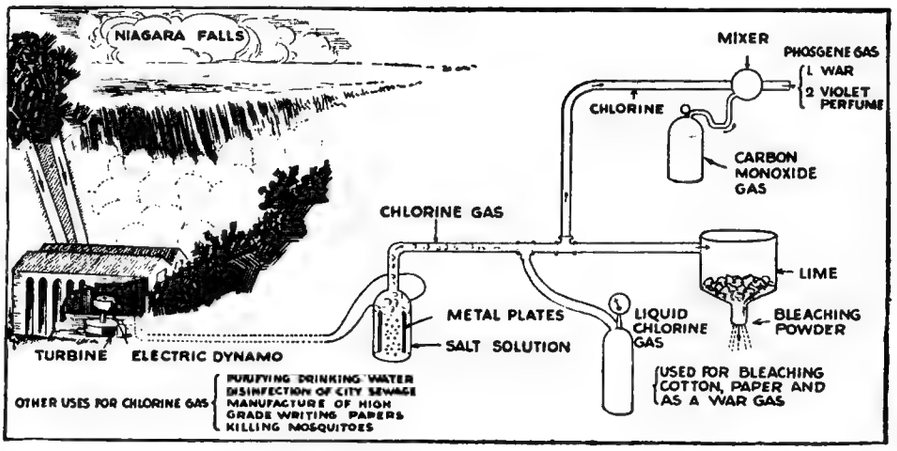
Poisonous Gases Find Uses in Industry

By ISMAR GINSBERG

BEATING the sword of war into the plowshare of peace is an aftermath of every war. But there has probably been no war, like the last, in affording so many opportunities of making use of the terrible weapons and dread agents used in combat for peaceful purposes, purposes which are as far removed from the original uses to which these materials have been put, as black differs from white. Who would think, who would imagine that the poisonous gases, those vile, virulent, inhumane agents of war-fare could be converted into the most refined and delicate of scents, contained in graceful bottles, to be used by fine ladies in scenting silken kerchiefs? The sow's ear has been converted into the silken purse!



There Are a Great Many Uses For Poisonous Gases in Industry For Both War and Peace-time Uses. The Cheapest Way of Making the Products From the Gas is to Use Current Generated at Large Hydro-Electric Plants for Producing the Gas, and Develop the By-Products in the Same Plant.

These wonders have been accomplished through the intervention of chemistry, that particular branch of chemistry which builds up complex products from simple beginnings,—synthetic organic chemistry. Furthermore, some of the poisonous gases have been put to direct use in industry, without it being necessary to make any change in them. While not detracting from the wonderful achievement of making a perfume out of a poisonous gas, it must be mentioned that the industrial uses, to which some of these gases have been put, are of much greater importance.

In the vicinity of Niagara Falls there has grown up, what may be called, the American electro - chemical industry. Many important processes have been rendered commercial successes by the application of cheap electricity. Cheap electric power can be secured only by using water-power to generate the current. This is why the electro-chemical industry has become centered around Niagara Falls. Its growth will depend to a large extent on the further application of the immense volume of water, that pours over the precipitous cliffs at Niagara, to the production of electric power. In passing it may be mentioned that practically the entire production of the metal aluminum in the United States is carried out at Niagara Falls.

One of the most poisonous of the war gases was and is made at Niagara Falls. This gas is called chlorine. It has been known and made for a long time, but has had comparatively few industrial uses up to the present time. Its main use has been and still is in the making of bleaching powder, or directly in the compressed state, for bleaching paper and textiles, especially cotton goods. There are also certain strictly chemical uses for this substance.

At Niagara Falls, caustic soda is made. Caustic soda is another name for lye, the corrosive substance that the housewife uses in cleaning out greasy sinks. The process of making caustic soda is to pass the electric current through a solution of common salt. Where the current leaves the solution, there is produced caustic soda, while where the current enters the solution, there is liberated the greenish, poisonous and intensely irritating gas, chlorine. Its properties rendered it a fine war-gas, for no human being can breathe even a small amount of chlorine and not immediately succumb to its evil effects.

What to do with the excess production of chlorine gas has always been a problem, and it has been more so than ever in

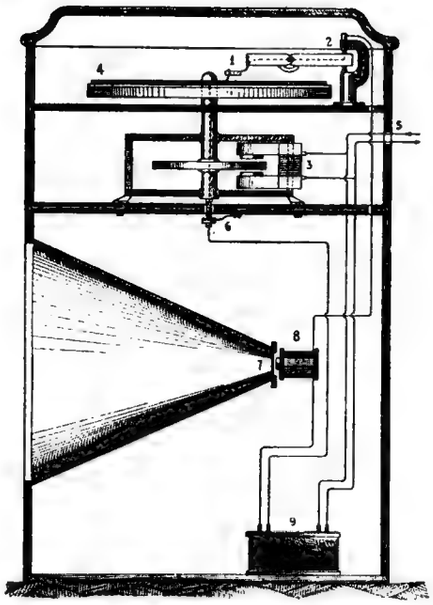
(*Continued on page* 90)

How To Perfect The Phonograph

By BURNIE L. BEVILL

THE phonograph's greatest fault—a fault that has baffled many great minds in their efforts to correct it—is the persistent screeching and grating sound that is produced by the needle scratching upon the record. Numerous arrangements have been tried and experimentd with to correct this fault, but so far, no satisfactory method has been brought out. Perhaps the diamond or jewel point needle has come nearer to solving the problem than anything else that has been used, but even this is imperfect and the metallic scratching sound remains. Various materials have been used for making the needles, including certain kinds of hard woods and artificial fibres, and these have proven partially satisfactory in ridding the music of its metallic quality; but at the same time, it has eliminated a considerable part of its purity and volume, thus impairing the reproduction.

The cause of the scratching sound that is produced by a phonograph is obvious. It is caused by friction between the end of the needle and the record, and any arrangement, however subtle, cannot entirely eliminate this friction. The only possible solution to the problem is to devise some system that will take the music away from this needle, deliver [illegible] udience and leave the scrat[illegible]nd. Electricity is the only medium that is capable of rendering this service, in my estimation. If some enterprising inventor will give his attention to this idea, I am sure he will be rewarded, as the idea is a very feasible one and only needs developing. I shall describe the idea that I have in mind for constructing a phonograph that employs electricity to produce the sound waves in the horn.



Here is an Idea Worth Developing. This Phonograph is Entirely Electrical From the Driving Motor to the Reproducer and Loud Speaker.

Before going further, I wish to call attention to the drawing, showing in detail the arrangement of the various parts of my scratchless phonograph idea. The diagram is a side view of the interior of the apparatus, in which is found an electric motor 3 which is operated by the city current coming into the machine through an opening at 5. (A spring motor will serve just as well for the machine.) This motor is made to operate a turn-table just as in the ordinary machine. In lieu of the tone arm that is found in the ordinary machine, is a double metallic arm, hinged in the middle to facilitate the outer sections being raised at will, provided with a metallic block which is connected to it by means of a spring and which has attached to it a tungsten stylus 1, and which is pivoted to a standard of the machine at 2. By means of the pivot at 2, the arm is capable of being swung across the record by the action of the grooves in the record just

(*Continued on page* 89)

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Yes, It's a Cold Winter in the Swiss Alps

At first glance one gains the impression that these objects are some sort of ancient stone monuments, but as a matter of fact they are telegraph poles entirely encrusted with a thick coating of snow and ice. So far as their usefulness to the telegraph company is concerned, they are quite out of business until the spring, but as picturesque objects of interest to tourists, they form a worthwhile attraction.

WE APPEAR IN JAPAN

We were highly gratified a short time ago to see ourselves in print in no less a publication than a Japanese magazine, devoted to radio and other subjects. The Japanese are keenly interested in all the latest developments in radio, and particularly no doubt in this latest invention of Mr. H. Gernsback's, the *Radio-Telephot*, which our readers will remember, as seen from the picture, appeared in the July number of SCIENCE AND INVENTION. We cannot enjoy all the nice things the Japanese editor has to say about this invention, but it would appear that he is very much in favor of it, in any event.

18

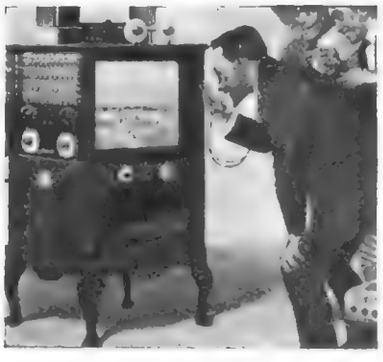
(三)蓄電機
(四)三極真空管
(五)電氣振動擴大裝置
(六)電磁石
(七)細長き鏡
(八)タングスチン球
(九)光線調節管
(十)集硝子

以上の中(一)より(九)迄は受映箱の前半部に取付けあり(十)は受映箱の觀覽者面側に取付けあるのです。

即ち(一)より(九)迄は活動寫眞の映寫機に相當し、後半部はスタジーンの用をなすのです。

偖て其作用を申しますると受信アンテナにて發振電波を受けますと、之は無線受信機の各部を通過する間に電氣振動擴大裝置を經て調整機から第二裝置の受映箱に送られます。

第二裝置の受映箱の(一)電波分析機で送信波長毎に之を分析して各々同調する眞空球(發振の超セレニウム數と同數あり)に導かれるのです勿論其道程にはインダクタンスや蓄電器がある事は普通の無線と同樣です。其眞空球の受信振動は擴大器によりて擴大せられまして電磁石に電氣は傳はるのです、電磁石は吸引力を起して其後端にある圓板模を振動させます(受話の受話機が電磁石で吸引振動を起して音響となる樣に)其の振動する圓模に小反射鏡が取付けてありますから、其振動に同時に鏡面も振動します。其時タングスチン球から發せられる光は光線調節管を經て鏡の振動面に投



Projection of Solid Objects

An ordinary projection is produced by a transparency printed on a flat film, and pictures printed on an opaque substance, may also be projected by the magic lantern. In the one case, the light is transmitted through them; in the other case, the light is reflected from their surface. In Germany a new type of projection apparatus called the *Episcop* has been developed, and our photograph shows a very beautiful example of its work. A human hand is projected on the screen, and it appears in such perfect relief as to be almost startling. Everything is reproduced with absolute clearness, and the work is so good that it is suggestive of high value for instructive purpose, the study of anatomy, or of botanical objects, crystals, minerals, and the like. By successfully adding a third dimension to projection, it is immensely more impressive. It now remains for Dr. Einstein to come to the front and add a fourth dimension.

Contributed by Dr. Albert Neuburger.

The Photo at the Right Shows a New German Projection Apparatus Which Has Been Designed for Projecting Solid Objects on the Screen. This is one of the Best Examples of the Projection of Such Objects That We Have Seen in Some Time. Note the Veins.

ACCIDENTAL INVENTIONS

The bayonet is said to have derived its name from the fact that it was first made in Bayonne, and its origin illustrates the proverb, "Necessity is the mother of invention."

A Basque regiment was hard pressed by the enemy on a mountain ridge near Bayonne. One of the soldiers suggested that, as their ammunition was exhausted, they should fix their long knives into the barrels of their muskets. The suggestion was acted upon. The first bayonet charge was made, and the victory of the Basques led to the manufacture of the weapon at Bayonne and its adoption into the armies of Europe.

Not infrequently an invention has been suggested by some trivial event, which would have passed unnoticed, had not a man with brain seen it.

Argand, a poor Swiss, invented a lamp with a wick fitted into a hollow cylinder through which a current of air was allowed to pass, thus giving a supply of oxygen to the interior as well as to the exterior of the circular flame.

At first Argand used the lamp without any chimney. One day he was busy in his work-room, sitting before the burning lamp. His little brother was amusing himself by placing a bottomless oil-flask over different articles. Presently he placed it upon the flame of the lamp, which instantly shot up the long, circluar neck of the flask with increased brilliancy. It did more, for it flashed into Argand's mind the idea of a lamp chimney, by which his invention was perfected.

One day the children of a Dutch spectacle-maker were playing with some of their father's glasses before the door of his shop. Setting two of the largest glasses together, they peeped through them, and were surprised to see the weather-cock of the opposite church brought close to their eyes. They called their father to see the strange sight. He looked through the glasses, and what he saw suggested to him the possibility of constructing a curious toy.

Galileo, hearing of the toy which made distant things appear close at hand, saw at once what a valuable help it would be in studying the heavens. He set to work and soon made the telescope.

Contributed by F. H. Sweet.

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MONEY FOR

By H. GER

IT has been stated frequently that the output of all the gold, silver and diamond mines of the entire world does not come anywhere near equaling in value the profits earned through the development and marketing of American inventions and processes.

From the days when the cave-dweller first turned a rough flint into a tool, human ingenuity has been at work devising means for converting the inert materials and live forces of nature into uses, conveniences and comforts for man. Yet the latest century of civilization covers the greatest of his inventions, and in the past eighty years some of the most epoch-making of them have been born. The era which crowned its achievements with the electric telegraph, the telephone, the submarine and wireless, which passed on from the trolley car and the automobile to the airplane, is now looking eagerly for more worlds to conquer.

We have frequently mentioned in these columns that it is the little idea that often brings fortunes to the inventor. Witness the founain pen, the mechanical pencil, the electric flashlight, the safety razor, the safety pin, the pocket book-match, the Klaxon horn, and hundreds of others.

There are thousands upon thousands of such ideas which may perhaps not be as well known as the ones mentioned here, but which, nevertheless, are veritable gold mines. It very often happens that it is the obscure little thing, that you would not think very much of, which proves to be the money-maker. Every industry has its peculiarities, and every industry needs new things that can be exploited by a clever inventor.

To those inventors, however, who think that fortunes can be made overnight simply from any ordinary idea, we wish to give a word of advice:

A gold mine is worthless unless you spend upon it time, money and effort. The gold must be mined by labor, brought to the surface, and there refined, before it can be marketed. It is the same with an invention. A good invention is a gold mine, but without exploitation the invention is as useless as a gold mine in the Pacific Ocean.

In other words, the inventor who thinks that all he needs to do is to make a model of his invention, then to patent the idea, and immediately become a millionaire, is the man we wish to disillusion.

Of course, there have been cases where a man took out a patent and sold it the minute it was issued, for a handsome figure, just as there have been great gold nuggets found in some rivers. Such cases, however, are exceedingly rare, and are the exceptions.

In bringing out an invention it is usually necessary to make a model to see if the device will work, or will cover the purpose for which it was intended. It is here the labor begins. The first model, 99 times out of 100, is either wrong, imperfect, or cannot be used for commercial reasons. Certain devices which look all right as models cannot be manufactured economically. In other words, the thing may look all right on paper, but may turn out to be impractical when the device is to be manufactured in a factory.

Frequently it must be re-designed entirely. For instance, an inventor had an idea of a very good automobile horn, which the writer saw some years ago. It was much smaller and had no large bell, as all the auto horns had at that time. The secret lay in the peculiar construction of the small horn opening which was a marvel as far as acoustics went. The inventor had made a wooden model that worked excellently. He then had a model made in aluminum. This also worked very well, even better than the wooden model. The inventor felt so encouraged that he took out a patent. Then he started a company to manufacture the product, and failed miserably—not because there was any inherent defect in the article, but rather because it was impossible to turn out the article in quantities and compete with horns in the open market. The casting was so complicated that only about 20 per cent turned out right. The other 80 per cent had to be discarded, and the cost of the pieces was so high that the advantage which the inventor had sought to obtain from his smaller model was entirely offset by the impossibility of marketing the device at a reasonable figure. Had this inventor known more about materials it would have been far cheaper for him to have made this horn in stamped parts, which could have been either assembled by screws or soldered together. This inventor, clever as he was, had not foreseen the commercial phase, and he not only lost all his time and money when the concern failed, but he lost his friends' money as well.

The reason why there are not more successful inventors is that they do not go deeply enough into their devices before they start manufacturing. A few dollars worth of advice, which may even be free, from a production man, or a superintendent of a factory in a similar line, will often point out the right way, while ignorance usually leads to disaster.

The simpler the idea, as a rule, the more complicated it becomes to turn it out commercially.

A model, or ten models, as we have stated above, means nothing. The ultimate test is, "Can the article be turned out at a price that will interest the users or buyers?" Naturally there are exceptions to this rule. Sometimes a basically new device will be invented and the patents will be such that they actually protect the device. In such a case, if the public or the buyer must have the article, the price means nothing. But in the long run it will be found that a similar article will come along which evades the patents, in some way going around them. In that case, unless a manufacturer is prepared to compete with the imitations, he will be wiped out entirely.

Gillette, of safety razor fame, had excellent patents on his razor, which, however, did not prevent a host of others from selling safety razors as well. These might not, might, or have been as good articles as that produced by the original inventor, but the fact remains that they sold. The Gillette people found it necessary to reduce their prices time and again to meet this competition—otherwise they probably could not have stayed in business.

It is true that if an article is designed correctly and a patent is obtained upon it, such an article, as a rule, brings somewhat more money than an imitation. There are, however, exceptions to this as well.

CONSTRUCTIVE ADVICE TO INVENTORS

If you have a good idea, first make a model or pattern, and see how it works out, to satisfy yourself that the device is all that you claim it to be.

Take out a patent. There are many patent attorneys, some of them experts in certain lines. For instance, there are patent attorneys who make a specialty of electrical patents, others of textile subjects, etc. By writing to the various attorneys you can readily ascertain what their specialty is, and the patent should be given to that attorney who has had experience in the proper line. This is quite important, because the value of a patent is contained in its so-called claims. Unless a patent attorney has had experience in a particular art, he will often not be able to draft claims that really protect it. It frequently happens that the patent would have been very much more valuable had the claims been drafted more carefully. Many an inventor has found this out to his sorrow.

Most inventors think that a patent is nothing but a picture showing the device. This is not so, and such belief is the most fatal error that inventors commit. The value of a patent, as just mentioned, is in its claims. The patent claims must not only try to cover every feature of the device as it is, but must also foresee any addition that might be made upon it in the future. In other words, the claims must be broad. If the patent attorney understands the article completely, he will make the claims broad enough to cover all such eventualities in future developments of the article.

Do not be afraid that patent attorneys will steal your ideas. Many inventors do not trust patent attorneys—which is a foolish thing, as there is practically no case on record wherein a patent attorney has defrauded an inventor of his invention.

If the inventor has filed his patent application, he has a certain degree of protection. It is, however, not full protection. Suppose the following case arises—and it is not an infrequent one:

An inventor has gotten up a useful device, and the case has been in the Patent Office for several weeks. He shows the idea to a manufacturer and wants to sell him the idea, whereupon he makes an agreement with the manufacturer to the effect that immediately upon the issuance of the patent, or the allowance of the claims of the patent, the manufacturer will pay him a certain sum. If this manufacturer is unscrupulous he might get up a similar device and try to patent it himself. If he can get around the patent in some way, he may beat the inventor to it, or, what may also happen, the manufacturer's patent may conflict with the

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YOUR IDEAS

NSBACK

inventor's, in which case there will be what is technically called an "interference." In other words, the Patent Office will not allow a patent to either of the two applicants, but will take testimony to find out who was the original inventor. This means that the inventor will be forced to fight for his invention, and unless he has money to do so, he soon wearies, and probably will compromise with the manufacturer at a much smaller figure. Such cases have actually occurred. For that reason it would be better not to attempt to sell a mere patent application unless the inventor manufactures it himself.

Once the inventor has an actual patent, he is on very much safer ground for dealing with the buyer. Our advice to all inventors, unless they have capital behind them, is to try to sell the patent, rather than attempt to manufacture the article themselves. Of course, again, there are exceptions as in everything else, but in the majority of cases the inventor, even if he has to be content with a smaller sum, will do better to sell the patent outright, rather than attempt to manufacture the article. It stands to reason that few inventors are good manufacturers. This means that the inventor has to become a manufacturer, and the outcome is questionable, whereas, if he takes the patent and sells it to the highest bidder, he will be very much better off in the end. It is true that, if he turned out to be a good manufacturer, in the end he might make more money. But he has no guarantee that from a financial or manufacturing standpoint he will have, at the end of a number of years, as much money as he could have made by selling the patent outright.

Beginning with the next issue, we shall print the experience of many inventors, so that would-be inventors can see for themselves what other inventors have done in order to become successful.

In the following paragraphs we reprint an article by a very able writer, who has compiled a list of inventions which have brought fortunes to their inventors:

"There is scarcely an article of human convenience or necessity in the market today that has not at some time or other been the subject of a patent, either in whole or in part. The sale of every such article yielded the inventor a profit. If we purchase almost any simple article, a portion of the price goes to the inventor. If we buy a sewing machine, or even a pair of shoes, the chances are that we pay a royalty to as many as a dozen or fifteen inventors at once."

In an official report, one of the chief examiners in the patent office said: "A patent, if it is worth anything, when properly managed, is worth and can be easily sold for from one to fifty thousand dollars. These remarks apply only to patents of ordinary or minor value. They do not include such as the telegraph, the planing machine, and the rubber patents, which are worth millions each. A few cases of the first kind will better illustrate my meaning.

"A man obtained a patent for a slight improvement in straw cutters, took a model of his invention through the Western states, and after a tour of eight months, returned with $40,000 in cash or its equivalent."

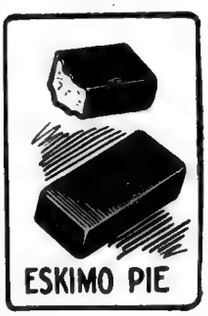
"Another inventor in about fifteen months made sales that brought him sixty thousand dollars, his invention being a machine to thresh and clean grain. A third obtained a patent for a printing ink and refused fifty thousand dollars, and finally sold it for about sixty thousand dollars. These are ordinary cases of minor invention, embracing no very considerable inventive powers, and of which hundreds go out from the Patent Office every year. Experience shows that the most profitable patents are those which contain very little real invention and are to a superficial observer of little value. The Goodyear Rubber patents, the sewing machine patents, the Bell telephone patents, have brought many millions of dollars to their owners. They are notable instances of the extraordinary value of simple but great inventions, when of such a nature as to enter extensively into the requirements of the general public.

IN the next issue of SCIENCE AND INVENTION the first story of a series, written by inventors themselves on how they achieved success with their inventions, will appear. These stories are of tremendous import to every inventor and would-be inventor, as well as all those interested in inventions and patents.—Editor.

Many apparently futile and insignificant inventions have proved of great importance, and this very fact has often operated to give undue encouragement to inventors. They feel that if an insignificant thing proved of value, their much more complicated one must be worth millions. In inventions it is the simple which counts; the simple is most secure and most comprehensive, the claim with one element is more basic than one with several.

Minor contrivances of less general need are still in some cases of great worth. An example is seen in Dr. Higgins' sliding thimble for umbrellas. This is a little contrivance for pushing umbrella springs and protecting the fingers. The Doctor states that he received more than one hundred thousand dollars in cash as royalties from his patents. He secured American, English, French, German and other patents at a small cost. His foreign patents have proved especially profitable.

Simple things like the collar button which turns down at the back yielded a large fortune. Harvey Kennedy realized $2,500,000 by introducing the shoe lace. Six people shared $10,000,000 between them through a patent on the ordinary umbrella. The shading pen brought its inventor an income of $200,000 a year, and from the baby carriage patent a lady drew more than $50,000. Profits amounting to $200,000 came to the man who thought out the automatic inkstand. The fireworks known as "Pharoah's serpents" put $50,000 into the pocket of the originator; Joseph F. Glidden, who devised the barbed-wire fence, received $1,000,000 in royalties. The man who discovered that a newspaper wrapper could be gummed benefited from his patent to the extent of a fortune large enough to enable him to found two schools for boys.



To add to this list of devices which have brought wealth and independence to their originators would be to mention scores of such inventions as carpet sweepers, eyeglasses, can-openers, stylographic pens, the seamless shield for women's dresses. Denison's shipping tag with eyelet reinforcement, the "thumb latch" of Philos Eli and John A. Blake, and the De Long hook and eye.

Every time anybody in the United States pulls the cap off a beer bottle or a soda water bottle, he puts the fraction of a cent into the pocket of William H. Painter, of Baltimore. A good many people have pulled these caps in the last few years, and Painter is consequently a very wealthy man. Yet the bottle cap is a small thing, an idea crystallized and patented. Painter carried his patent in his pocket for six years before he succeeded in interesting capital in its manufacture. Then a man of means advanced the necessary capital, in return for a half interest in the patent, and formed a company. At the end of the first year he and Painter each are said to have netted $57,000. The invention has crowded all other stoppers off the market, and a big factory in Baltimore turns out the caps by the million every day.

Before the time of Painter, a man named DeQuillfeldt invented a stopper that took the trade away from the corks of our youth. This stopper was of rubber and was tightened by a wire attachment, which was pulled down as a lever on the outside of the bottle. A decade ago such stoppers were generally used on milk and beer bottles. Those who bought the patent are said to have made $15,000,000.

An idea that is perhaps simpler than the stopper is the "the hump" on hooks. Women had been fastening their dresses with hooks and eyes for a generation and more, and it is probable that some one made a lot of money out of the original invention. Hooks had a way of coming unfastened, much to the chagrin of the neat

(*Continued on page* 58)

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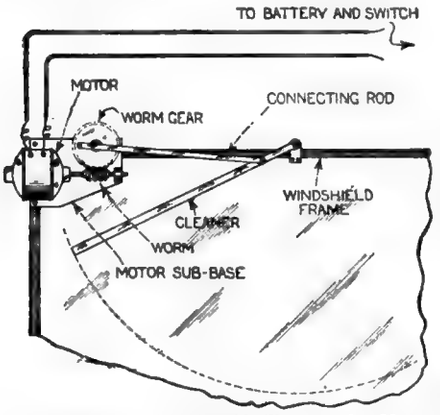
MOTOR HINTS

FIRST PRIZE, $25.00

ELECTRIC WINDSHIELD CLEANER

This automatic electric windshield cleaner consists of a small electric motor connected to a worm gear, which operates a bell crank By means of a connecting rod to the cleaner, this causes the cleaner to swing back and forth across the windshield, thus keeping the glass clean and also relieves the driver of the necessity of removing one of his hands from the wheel to operate it. It is geared down by the worm drive to make about twenty movements per minute. I have found in actual practice that this windshield cleaner keeps the glass clean in the worst kind of a storm.

Contributed by A. M. HULCHINGS.



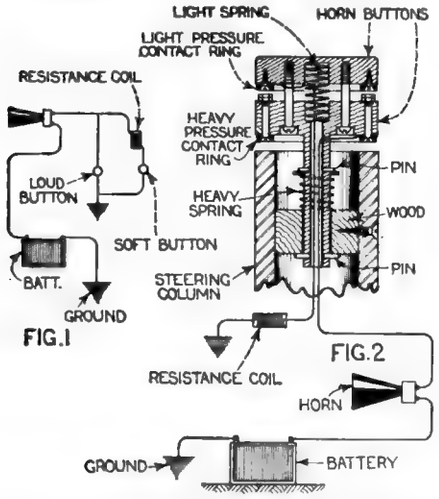
A Motor-Driven Windshield Cleaner, the Motor Being of the Six-Volt Type and Operated from the Storage Battery.

SECOND PRIZE, $15.00

TWO-TONE HORN

I have used this two-tone horn on my car for two years, and can now ride through the city streets without the embarrassment of startling everyone whenever I blow my horn. I procured a resistance unit which is used on a six volt lighting system for dimming the lights, and connected the same in series with number one contact on the electric horn button, thereby slowing down the horn motor and softening the tone of the horn. The diagram given herewith shows how the horn button is constructed and applied in conjunction with the resistance unit. The figure also shows another way of obtaining the same results by using two buttons.

Contributed by THOMAS MCCARTIE.



A Two-Tone Push Button Which Can Be Mounted on the Steering Column So as to Give a Low Note for Ordinary Driving and by Pushing Real Hard on the Lever Note for Country Driving

SPECIAL NOTICE

Due to the fact that many of our readers have written to the Editor complaining that the "MOTOR HINTS" Department of SCIENCE AND INVENTION *has been too restricted in the past, and not broad enough in its scope, we hereby give notice that this department will be changed beginning with the June number, when we will start a series of interesting and valuable articles on motor hints, each article complete in itself and covering practical problems met with by motorists, and how they have been solved. These articles will be prepared by experts in the automotive field.*

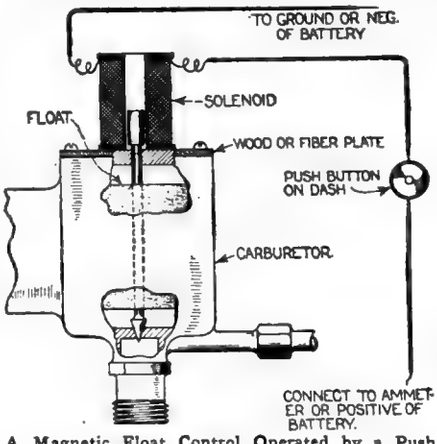
THIRD PRIZE $10.00

MAGNETIC CARBURETOR TICKLER

I am giving you herewith a short description of a very simple carburetor tickler.

This outfit consists essentially of such a fibre or hardwood spool as one can buy in any 5 and 10-cent store, wound with about 35 turns of No. 20 or No. 22 C. C. wire, a fibre or wood base to attach the spool to carburetor, a 10-cent wood push button for the dash and the necessary wire to make connections to ammeter or battery as per diagram. When starting the motor, it is only necessary to press the button a number of times and the solenoid action of the spool will lift the gasoline float, and fill the carburetor quickly, thereby making starting easy. As there is no direct electrical connection on the carburetor proper, there is absolutely no fire danger.

I have installed this device on my car and it works beautifully. On 12-volt electrical



A Magnetic Float Control Operated by a Push Button from Driver's Seat, So as to be Able to Flood the Carburetor at Any Time Desired; Particularly Useful in Starting Engine.

systems it is only necessary to increase the amount of wire turns, or to use a smaller size wire.

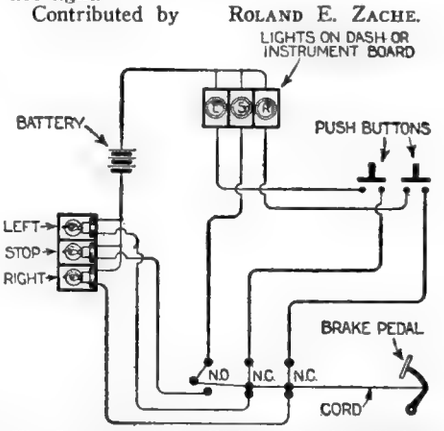
Contributed by FRANK G. DUROY.

INTERLOCK SWITCH FOR "STOP" AND "TURN" SIGNALS

In combination with the "stop" light on my car, I have a "left" and "right" light, operated by push-buttons on the steering post. In many cases it would happen that the "stop" light would go on when one of the other lights was on. In order to avoid confusion to the driver behind, I wired the lights as shown. I arranged two normally closed switches and one normally open switch, mechanically interlocked with the brake pedal. If I have a "left" or "right" light on, this will now go out when I step on the brake, leaving the "stop" light only in the circuit, thus eliminating two contradicting signals in the rear. When the brake pedal is released, the "stop" light will go out and the "left" or "right" light will go on automatically, until shut off by the push-button.

Besides this feature, I placed three low candle-power bulbs in series with each of these lights. These bulbs were marked "left," "stop," "right," and were mounted behind empty push-button plates on the instrument board. These lights warn the driver that the signals are on, and should be turned off when he has rounded the corner; or they serve the purpose of notifying the driver that one of the signal lights is burned out, in case the tell-tale lamp does not light.

Contributed by ROLAND E. ZACHE.



The Inventor of this Rinktum Provides Tell-tale Signal Lamps on the Dash for His Stop Signals, and Has Also Ingeniously Provided an Interlocking Switch Arrangement Tied Fast to the Brake Pedal, so That if He Should Use the Brake, the Stop Light Will Flash on at the Rear, but the Right and Left Switches Will Be Opened Simultaneously, so as to Prevent Confusion of Signals.

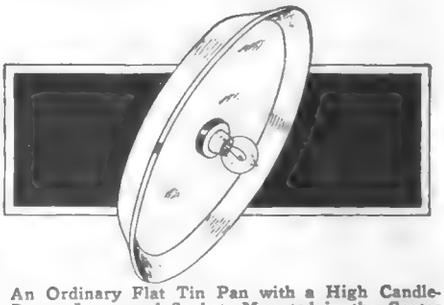
A "GROUND" LIGHT

A handy addition to the lighting system on a car is a ground light or what is sometimes called a courtesy light. It is simply an arrangement to light up the ground around the car and is invaluable when passing other cars on dark narrow roads when both have their headlights dimmed.

The simplest arrangement is a large pie plate with a socket mounted in the center. This is mounted under the car just back of the front axle, clips under convenient crank case bolts will usually serve to hold it securely in place. A large bulb of at least 21 C. P. is inserted in the socket and a switch arranged convenient to the driver to cut the light on and off.

Switching the light on will flood the ground under and around the front of the car, a great assistance when articles are dropped in the dark, in running into a dark garage and even as an auxiliary to the headlights which too often fail to light the ground immediately in front of the car.

Contributed by THOS. W. BENSON.



An Ordinary Flat Tin Pan with a High Candle-Power Lamp and Socket, Mounted in the Center of It. This Whole Contraption Fastened Underneath the Car Provides a Very Good "Ground Light," as an Aid in Marking Out the Car When You Have the Headlights Dim, and Also for Shooting Trouble at Night Underneath the Car.

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Magic for Everybody

By PROF. JOSEPH DUNNINGER

No. 2 OF A SERIES

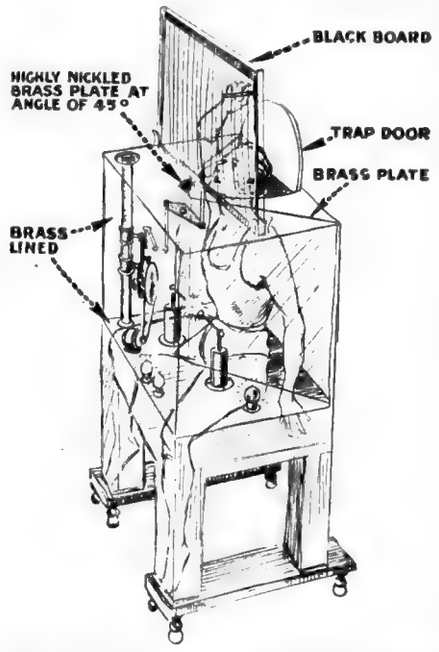
COMMITTEE
PLATE OF ALCOHOL
MATCHES
OPAQUE BLACK INK BOTTLE
MESSAGE WRITTEN ON SLIP OF PAPER BY ONE OF AUDIENCE.
1
FALSE FINGER TIP FITTING INTO NECK OF BOTTLE
MESSAGE
BLANK SLIP
3
INK
2
MESSAGE CRUMPLED INTO BALL AND PLACED IN INK BOTTLE
4
MAGICIAN STICKS FINGER INTO BOTTLE AND TAKES FALSE TIP AWAY, APPARENTLY CHANGING HIS MIND HANDS BOTTLE TO ONE OF COMMITTEE, DIRECTING HIM TO BURN THE MESSAGE
5
MAGICIAN PALMS MESSAGE AND READS IT

Here is the Clever Ink Bottle Trick Described Among Others This Month by Professor Dunninger. You Write a Message on a Piece of Paper, and Place it in What You Believe to be a Bottle of Ink; Afterwards the Magician Reads Your Message as the Paper is Burned in a Dish of Alcohol—But Does He?

A UNIQUE TELEPHONE BOOK TEST

MUCH has been said and written with reference to the truth of mental telepathy, mind reading, thought transference, etc. The writer herewith emphasizes the fact that in exposing problems boundering upon the psychic senses of the human mind, it is not his desire to belittle the truth and scientific value attached to the sincere demonstrations which are mentally possible. Mind reading is an absolute scientific fact, the fundamental principles of which have been sadly neglected, and as my scientific readers will no doubt agree, it is human nature to disbelieve anything which one does not thoroughly understand. It is the belief of the writer that there is nothing that the human mind can possibly conceive that is not probable, but, as his many genuine demonstrations in the past before men of prominence have proven, there is always a doubt as to whether effects of this kind are brought about by mental thought waves, clever methods of trickery or concealed mechanical devices. The study of mind reading is not alone based upon an education obtainable only through the reading of various volumes upon the subject, but the training depends also upon many years of practice and actual demonstration. As it is my desire to give the readers of SCIENCE AND INVENTION a series of experiments along this unique form of entertainment, that can be accomplished with a very small outlay of money and an unusually small amount of practice, I am opening this month's article with the explanation of one of the most interesting and seemingly difficult tests in so-called mental telepathy. I might further add that an expert after years of practical demonstration and experience could not produce a more weird and unbelievable result than the one I am about to describe. Yet, I know that many of my readers will receive an endless amount of amusement by producing this effect, and many comments and sincere congratulations from their friends, who will compliment them upon being possessed of a sixth sense. Briefly, the effect:

The mind reader and his associate enter a room together with a committee who have been invited to test the ability of the mind reader. A telephone book is inspected and is found to be of ordinary type and absolutely free from preparation of any kind. It is explained that the mind reader is to leave the room and during his absence the committee are to select one name in the many thousands printed in the book. They are further asked to memorize the number of the page upon which the name appears. Prior to the performer's leaving the room, his eyes are bandaged and securely blindfolded, making it quite impossible for him to see. The effect may be heightened, if desired, by having strips of adhesive plaster placed over the bandages. After the name has been decided upon, the performer is led into the room and asks permission to hold a member of the committee by the wrist. This means of contact, he explains, will aid him in reading the mind of the subject. After a few moments of silence, in a low, slow tone of voice, he calls the number of the page decided upon, which, for example's sake, we will say was page 765. He now requests his subject to slowly run his finger down the columns of this page and the moment the subject's finger reaches the name thought of, the mind reader requests him to stop. It is naturally found to be correct, much to the amazement of the spectators.



The Mystic Spirit Slate or Blackboard and How the Trick is Done. The Man Inside the Cabinet Does the Writing on the Rear of the Slate or Blackboard Once it is Placed in Position, Extending the Hand Through the Little Trap Door on Top of the Cabinet. The Gears and Other "Works" Seen in the Front of the Cabinet Are Mere Camouflage to Mystify the Audience, and They Think They See All the Way Back Into the Cabinet, Owing to the Reflection Illusion Caused by the Two Polished Metal Plates or Mirrors Placed in Triangular Formation as Shown, with the Peak of the Triangle Toward the Audience and in the Center of the Cabinet.

Now, for the explanation. As in all mysteries that are most bewildering, the explanation is extremely simple. Before the test takes place, the mind reader provides himself with an apparatus, as is herewith illustrated. This consists of nothing more than a so-called plate lifter, purchasable in any of the many novelty shops. It consists of a small rubber bag, attached to a long piece of rubber tubing, to the free end of which is affixed a rubber ball. This apparatus is concealed beneath the carpet in the room where the demonstration takes place. The assistant, who seemingly is disinterested in everything, other than seeing that the mind reader's eyes are properly blindfolded, etc., is really the so-called "information bureau" for bringing about this effect. He secretly makes note of the name in the book selected, also the page upon which it appears. After the selection has been made, and the blindfolded wonder-worker is led into the room, the assistant sees that his foot rests upon the part of the carpet directly above the rubber bag. This is easily located, as the design of the rug discloses its hiding place. The assistant now moves to the opposite side of the table and stands with his foot directly on top of the concealed rubber ball. The interested spectators are asked to group around the table and to assist by concentration. Seven sharp taps upon the ball secretly advise the "mind reader" that the first digit to the page is number 7. Six taps and then

(*Continued on page 62*)

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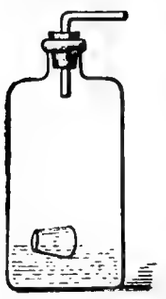
Scientific Problems and Puzzles

By ERNEST K. CHAPIN

THE FLOATING CORK

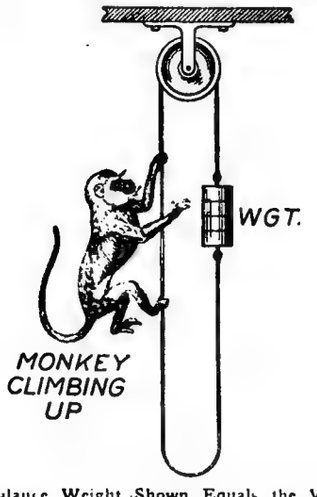
IN Fig. 1 we see a cork stopper floating on the surface of a little water in a bottle. If the mouth of the bottle were now connected to a tank of compressed air, would the level at which the cork floats be affected in any way?



If Compressed Air is Fed Into the Bottle, Will the Cork Sink Lower or Rise Higher in the Water.

THE CLIMBING MONKEY

Mr. John M. Minor of San Pedro, California, asks for a solution of a very interesting puzzle which was originally proposed, I believe, by Lewis Carroll, in *L'Astronomie*, July, 1917. It reads somewhat as follows: "To one end of a rope passing over a fixed pulley a monkey is clinging while his equal counterpoise is fastened to the other. The monkey now begins to climb up his end of the rope. What happens to the weight at the other end? Does it go up or down or remain stationary? And if both go up, which one will reach the pulley first?" To this form of the problem a slight modification might be made which would eliminate the possibility of an accumulation of rope on either side of the pulley, that is, by letting both ends of the rope extend downward for some distance below the weight and monkey and be joined to form a continuous rope as shown in Fig. 2.



The Balance Weight Shown Equals the Weight of the Monkey. If the Monkey Starts Climbing the Rope, What Would Happen to the Weight?

Another question might be added. Suppose, instead of climbing the rope the monkey lets go, drops for some distance, and then catches hold again. What would happen, considering friction in rope and pulley negligible?

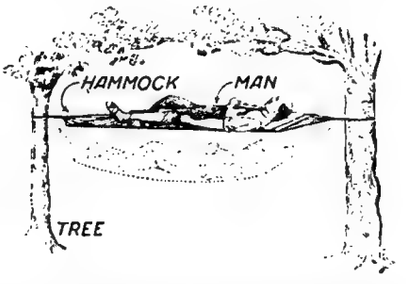
HANGING A HAMMOCK

A man who had considerable experience in sleeping in the open was telling another the proper way to sling a hammock. "Hang it quite straight and level," he explained, "as it is much more comfortable that way, than when hung in form of a loop as so many people hang theirs."

"But aren't the cords and the ropes of the hammock under a much greater tension and therefore more apt to break when it is hung that way?" inquired his friend.

"Not at all," was the reply. "You see, each rope has to bear but half of the total load which is of course independent of the manner in which the hammock is hung."

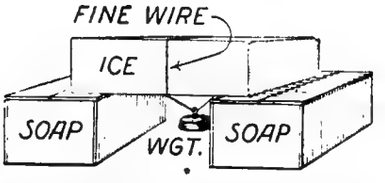
Who do you think was right about it?



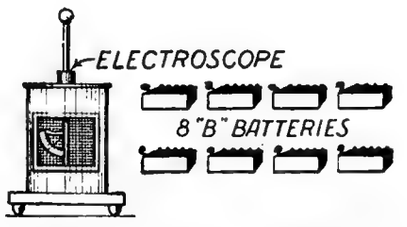
Is There a Greater Strain on the Ropes Supporting the Hammock Rigidly Between the Two Trees, as Compared to the Lower Sagging Position Shown in Dotted Lines?

PASSING A WIRE THROUGH A CAKE OF ICE

Lay a small cake of ice across a gap between two boxes and request someone to pass a strong fine wire through it without disturbing either the boxes or the ice and of course without severing the latter. If they can't do it, show them how simple it is.



Can You Pass This Fine Wire Through a Cake of Ice Without Showing the Line of Demarkation, the Cake of Ice Remaining Whole?



A Man Wishes to Charge an Electroscope to a Potential of 1,000 Volts, and He Possesses Eight Radio "B" Batteries, Each One of Which Supplies a Potential of 22½ Volts. Could You Tell Him How to Obtain the Necessary 1,000 Volts D. C. From These Eight Batteries?

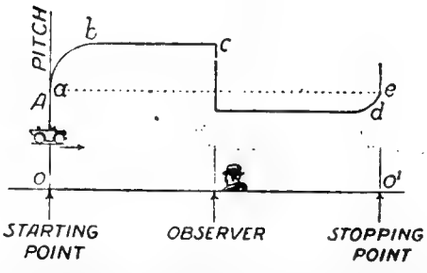
WANTED: 1000 VOLTS D. C.

An experimenter needs a potential of 1000 volts D. C. for charging a gold leaf electroscope. The only source of E. M. F., however, which he finds available, is a set of eight 22½ volt batteries. Can you tell him how he can very easily get the necessary 1000 volts?

THE PITCH OF THE FIRE-BELL

Probably everyone has noticed how the pitch of a bell on a fire-engine changes as the vehicle changes speed or passes an observer. This happens even when the bell is rung at a constant rate and the air is perfectly still. Through what changes would the pitch of such a bell appear to pass if the observer were watching the passage of a fire-engine from a point, say, midway between its starting and stopping points on a straight course?

(*Continued on page* 60)



Through What Changes Would the Pitch of a Fire Engine Bell Appear to Pass to the Observer Listening to the Bell from a Point Midway Between the Starting and Stopping Points, Along a Straight Course Followed by the Engine.

Another Step Towards Whole Truth About Evolution

By ROSWELL S. BRITON

The discovery of a new and better means of removing the rock formations from fossils marks another step, small but important, towards the ultimate accumulation of fairly complete data on the disputed points of early natural history, including the puzzles of human evolution. For science must rely entirely upon the revelations of newly-found fossils to get the facts about human and animal life of prehistoric times.

The new method of cleaning fossils employs the [illegible]ylene flame, which has one of t[illegible]ble temperatures known. T[illegible]me has been used com[illegible] time, but the paleontologists of the California Academy of Science, at Golden Gate Park, San Francisco, have just introduced it for the first time to the purpose of uncovering fossils.

Petrified bones, tusks and shells, and other fossilized parts of prehistoric animals or vegetables, are found imbedded in rock formations, where they have been lying for centuries. The rock formation serves the modern scientist well by having protected the fossils from weather and other deteriorating forces, through the countless years of geologic epochs. But the same rock formation becomes a serious obstacle when the scientist starts to extract the fossil.

It is difficult enough to cut or blast out the block of rock incasing the desired fossil, without destroying the fossil. But it is still harder to remove the final coating of rock, next to the fossil itself, without damaging the precious relic of prehistoric ages.

The paleontologists of the California Academy of Science solved the problem by using the oxyacetylene flame and a plain drop of cold water. After the bulk of the rock formation has been chipped off, the flame-and-water treatment is applied to the remaining layer of rock, which is stuck fast to the fossil.

(*Continued on page* 68)

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THE CONSTRUCTOR

A Home-Made Compound Microscope

By F. G. MARSA

THIS article is intended more for the intrepid experimenter who builds things on the spur of the moment and who is too anxious to see how "the thing will turn out" to take the necessary time to build a precision model.

The more exacting scientist, thinking in terms of finely powdered millimeters might frown upon the somewhat "rapid-fire" construction of my apparatus, but the bold dabbler in science not so blessed with the costly laboratory equipment, will find here a suggestion for making an instrument which he can drop on the floor without "mussing up the hair-breadth adjustments" or knocking off a precious square cm. or two of fine finish.

The entire apparatus can be built in one evening after one has gathered the odds and ends necessary for its construction and outside of the few dimensions shown in bold figures which are the smallest sizes permissible to insure the proper fitting together of the parts, the amateur mechanic is not bound by any caliper or micrometer rules and can use whatever sized material he has handy.

The apparatus consists really of two separate instruments, A and B. A is a focusing slide support or *stage* with its condensing lens and mirror, and B is a compounding attachment. Instrument B can be used either with the instrument A or it can be used in connection with the *Ultralens* microscope.

The optical equipment necessary consists of the familiar tripod microscope, which consists of two double convex lenses of about 1¼" combined focal length, and the triple magnifier with its bellows shaped folding case, giving a range of focal lengths from ⅜" for the three lenses combined, up to 1¾" for the largest diameter lens used alone.

If your optical dealer is too busy selling shell rimmed eye harness and single barrel periscopes, to bother about carrying the lenses, almost any member of the ancient guild, whose insignia consists of the three gilded spheres, will let you have the lenses for much less than he would ask of his own uncle.

For the condenser use the bull's eye lens of an old flashlight, preferably the smaller size having a focal length of about 1". A square mirror about 2"x2" or any convenient size is also needed.

We'll first take up the construction of instrument A. The stage and condenser shelf is cut out of a piece 6"x3" of any gauge brass or iron from 1/32" to 1/20" thick, drilling or punching two ⅜" holes at least ⅞" apart as shown in Fig. 1, bending the piece along the dotted lines into the shape shown in Fig. 3, the two wings W hugging the stand L, allowing a free up and down movement of the stage S without any sideplay. The larger wings F are bent into the shape shown after the focal length of the condensing lens has been found, the idea being that the wings F form a shelf for this lens, supporting it at such distance below the top of the stage, that the light reflected by the mirror is brought to a focal spot upon any object laid on the stage.

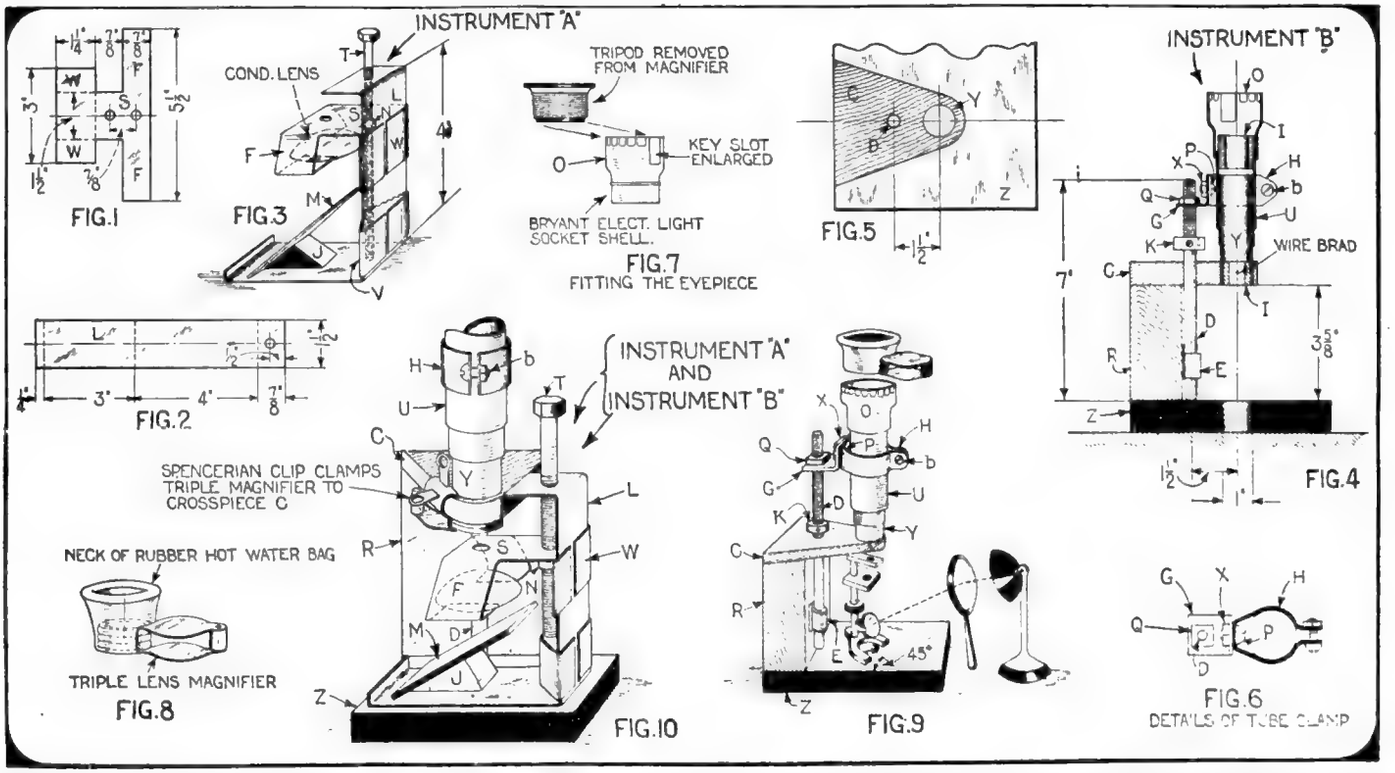
Out of a piece of 1/16" thick band iron 1½" wide by 8" long make the stand L, drilling a ⅜" hole about ½" from the end as in Fig. 2, and bending the piece along the dotted lines into an L shaped stand and for the stage S. Strap V is made of any thin metal sheeting about 1"x3" and serves to keep the bolt T in place.

T can be either ¼" or ⅜" in diameter and not less than 5" long, and it is threaded for at least 4" of its length. A square nut N rests against the stand L and is kept from turning when the bolt T is twisted, by soldering it to S or by reason of its size. It lowers and raises the stage and holds it at any desired height. A lead wedge J supporting the mirror M at any angle completes the stage and the condenser of the microscope.

MAKING THE COMPOUNDING ATTACHMENT B

To a wooden base Z of 1"x6" material (Fig. 4) (and with a 1" hole drilled in center if the *Ultralens* microscope is to be used) nail an upright R of 2"x4" lumber, 6" long, laid on its long edge, and screw to this upright a socket E of the door bolt (or make a strap of light iron). In a piece of lumber 1"x4" by 6" long drill two holes not less than 1½" apart, one hole large

(*Continued on page* 64)



The Simple Drawings Herewith Show How to Make a Powerful Compound Microscope at An Insignificant Cost. A Microscope in General is an Instrument Which the Average Experimenter Does Not Care to Spend a Lot of Money On, As the Chances Are He Will Not Use It Very Often, Unless He Happens to be Interested in the Study of Biology or Other Special Branches of Science. This Article, We Feel Sure, Will Prove of Unusual Value and Interest to All of Our Readers, and Presents Data Which We Have Been Looking for for Several Years.

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The Remarkable Photographs Reproduced Above Were Taken by the Author of this Article, Mr. William P. Sipes, and Therein He Explains the Few Simple Rules to be Followed in Taking Photos of Fireworks, Such as These. Now That the Summer Season is Approaching When Many Firework Displays Are Given at Various Amusement Parks and Fairs, the Amateur Photographer Will Find a New Field of Interest Opened to Him.

Fireworks Photography

Written and Illustrated by WILLIAM P. SIPES

NO branch of photography is so little practiced as night *fireworks*. And yet it is open to anyone having a small folding camera or kodak. My own beginning in this branch of work was met by many obstructions—but by overcoming these step by step I have now worked out a system whereby anyone can secure splendid results.

The object of this article is to lay before the camera owner how he may duplicate the results of the illustrations herewith.

The camera best suited is the folding type, such as the kodaks. Those having view finders and focusing scale—and a lens working at F-7.7 or F-8. or U. S. 4. Your camera or kodak should have a view finder. As it is night while taking this kind of a picture, it is difficult to tell if what you see in a finder is in the field of view. These finders are in the cross shape—for horizontal and vertical positions. You will use the vertical position on all, except large set pieces and illuminated airplane flights. Take a small p[illegible] adhesive plaster tape, cut a li[illegible] opening in view finder. C[illegible] d place over the two c[illegible] leaving only the opening that will show for a picture in a vertical position. You can see now just what will show in the picture. Set your focus at 100 feet and your lens stop at F 7.7 or F 8, or U. S. 4. As only time exposures can be taken, you will need something to hold the camera steady, I used a tripod at first. Spreading two (2) of the legs out in the rear and the other one pointing out in front, but drawn back, as your camera is pointed upward while the front leg is so placed. I moved it forward or backward and to either side as the case required. But unless you have a smooth surface under you, this method has its faults; it may tilt forward or to one side—thus cutting out an important part of the picture. I have used a cigar box, setting it on the ground and with my right knee bent flat before me, the box in front of it, I tilted the camera to about 45 degrees, by moving the bottom back and forth.

But the method I now use, and which I find superior to all others, is a metal tripod —on this I use an Eastman optipod. This works on a ball and socket, and is locked in any position by a large thumb nut. A ¼ turn of this nut will permit one to move (or point) camera in any direction desired.

Having outlined the necessaries required, we will now be ready to make the exposure. I will first explain when using an optipod on tripod. But the optipod can be used equally well clamped to the side of a box or chair back.

Screw the optipod on tripod. Clamp the camera on it, in same manner as you would on a tripod screw. Turn tripod around until the thumb screw is on left hand side. (You will use left hand for tightening this.) Loosen this and point camera in front of you, facing the spot where fireworks are to be set off. Next take your cable release or bulb in your right hand, placing same between first and second finger, as in making all exposures, but further back, about where the second finger joint is. Next (while cable or bulb is resting between your fingers) grasp the kodak bed, placing thumb on top and fingers underneath. Now by a ¼ turn of the nut in your left hand you can tilt kodak at any angle upward. Do not untighten the binding screw more than to permit the kodak to be moved freely. Watch where fireworks are set off. The

(*Continued on page* 88)

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Production of High Vacua in the Laboratory

By RAYMOND B. WAILES

PART 2—MERCURY VAPOR PUMPS

PRACTICALLY all devices in which a high vacuum has been employed, have been exhausted by means of the mercury vapor pump. The mercury pumps previously described, operate upon the Torricellian vacuum principle Here, the descent of a body of mercury to the barometric height creates a vacuum

Fig. 1 Shows All-Glass Mercury Vapor Vacuum Pump. The Boiler C, Containing Mercury, is Placed in the Flame of a Bunsen burner. The Vessel to be Exhausted is Connected to B. A Mechanical Vacuum Pump is Connected at A, While the Inner Condenser W, is Cooled by Water Circulating Through It.

at its head. In the mercury vapor pump a blast of mercury vapor produces the same effect.

A mercury vapor pump is shown at Fig 1. It is made of Pyrex glass, glass that admirably resists elevated temperatures The pump consists of a boiler C with a throat N. The tube to be exhausted is connected at B. The arrows show water entrances and exists. This water flows around the throat N and the right portion of the pump, serving to condense the hot mercury vapor as it issues from the throat N. The condensed mercury vapor, now in the form of small drops, passes along the return tube R to the boiler, where it is vaporized again by the Bunsen burner which is placed beneath it. Only a small quantity of mercury is required for its operation, which is continuous.

The principle of the pump is as follows: Hot mercury vapor issues from the throat N and streams on. Air is at the same time sucked in through the annular channel T. Since T is connected with the tube being exhausted, the tube itself will be evacuated

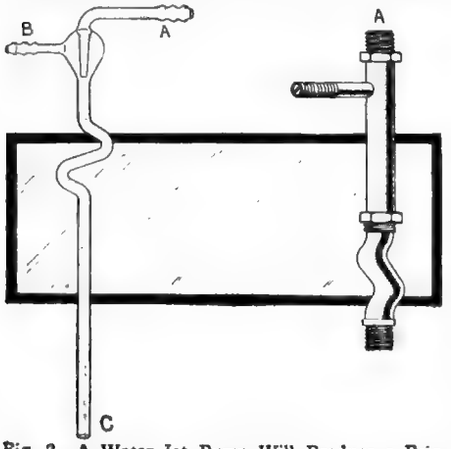

Fig. 2. A Water Jet Pump Will Produce a Fair Degree of Vacuum. This Type of Pump is Frequently Used to Back Up a Mercury Vapor Pump.

As fast as the air is sucked from the tube under evacuation, it is withdrawn from the system by means of a mechanical pump connected at A. The mercury vapor does not pass out with the air at this point, since the walls of the inner condenser W are cooled by the inflowing water passing in the direction of the arrow, thus condensing the mercury which runs along tube R, back into the boiler where it is volatilized and goes through the above cycle once more.

To produce extremely high reductions of pressure, two mercury vapor pumps are operated together

The simplest type of vacuum pump is shown connected at A, Fig. 2. One of these pumps is shown at Fig. 2, and is called a filtering or aspirator pump; when connected to the mercury vapor pump, a backing pump.

In this simple type of vacuum producer, water is admitted at A and its downward course creates a diminution of pressure at B with a consequential sucking in of air. This air and water combine to produce a foam which leaves the instrument through the lower stem C. The longer the stem C, the higher will be the vacuum under the same water pressure, because the falling of the water through the tube is the operating principle of the pump. The tube is bent as shown to cause a good foam mixture, which, at the same time, shortens the length of the tube The metal pump shown operates upon the same principle. It is screwed into the ordinary threaded water faucet at the sink

METAL FORM OF CONDENSATION PUMP

Instead of making the condensation pump of a high resistant glass such as Pyrex, metal can be used A diagrammatic view of a commercial pump is shown at Fig. 3. A is a boiler inside of which is a stack F. An inverted cup, E, is supported above the stack F. The walls of A are water cooled by jacket J, water flowing in the direction of the arrows. The vessels to be exhausted is connected on at C, and the backing pump at B. D is mercury poured into the boiler through B. It passes also into the inner portion of F through small holes in the walls and bottom of F.

An electric heater is used to volatilize the mercury, the resulting mercury vapor passing up F, striking E and being deflected, passes down the outside of F pushing air before it. As the air is pushed before it, a vacuum is created behind it, the vacuum taking place in the vessel connected with C. The hot mercury vapor is condensed to metallic mercury by the water cooled walls of A, and flows through the small holes in the bottom of F to the interior to be vaporized again.

ABSORPTION OF GASES BY CHARCOAL

Charcoal absorbs many times its volume of certain gases. This effect is often utilized in the production of a vacuum. Fig. 4 is schematic diagram of this principle. The charcoal is contained in a small trap tube and the tube is immersed in liquid air.

Liquid air is also used to remove any mercury vapor which might be present in the evacuated vessel. The experimenter can use gold-leaf instead, the gold-leaf being placed in a trap tube.

Very remarkable results are obtained at low temperatures with charcoal. Below liquid air temperature it absorbs gases with such vigor as to produce very high degrees of exhaustion. A special liquid air container has been constructed in which the vacuum surrounding the inner container was produced by a stick of charcoal. The liquid air lies in the inner vessel, the surrounding vessel contains the charcoal. The air chills the charcoal and it at once absorbs the gases in the annular space, giving the thermos-bottle effect.

It is a simple way of obtaining a vacuum; so simple that it is a pity it is only applicable at such low temperatures.

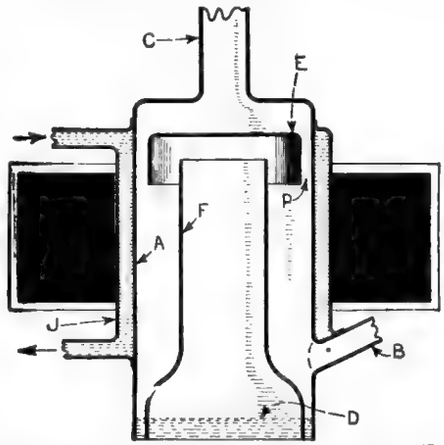

Fig. 3. A Condensation Pump Constructed of Metal is Shown in This Figure. The Air from the Vessel Under Exhaustion Connected at C, Passes Out C, Through Passage P, and is Removed via B, by Means of the Backing Pump.

GENERAL

The production of vacuum is acquiring increased importance day by day. Going back to the seventeenth century, Torricelli defined the space above the mercury column of the barometer as a vacuum. This is perhaps the first approximate vacuum that man ever produced. Many years ago near the middle of the last century, the great Robert Bunsen, one of the most illustrious names in the realm of chemistry, introduced the vacuum in the laboratory for purposes of filtration. A perforated platinum cone was placed in the bottom of the funnel and the regular filter paper introduced. The stem of the funnel was passed through a double perforated cork which was inserted in a specially strong flask, and a vacuum was produced by a water column pump.

The chemist has improved on all this and a small water jet pump and the Gooch filter has marked a great advance in vacuum filtration.

In the world of illumination and now of radio, the production of vacuum, play an all-important part, and one curious thing is that the complete vacuum as far as we know, has never been produced by man.

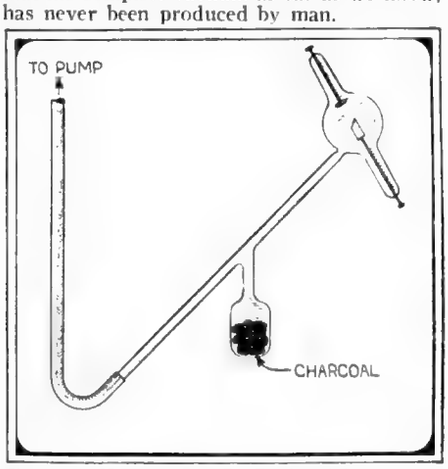

Fig. 4. A Vacuum Can Be Produced by Absorbing the Gas in the Vessel by Charcoal Cooled to the Temperature of Liquid Air.

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How to Use Your Camera

By Dr. ERNEST BADE

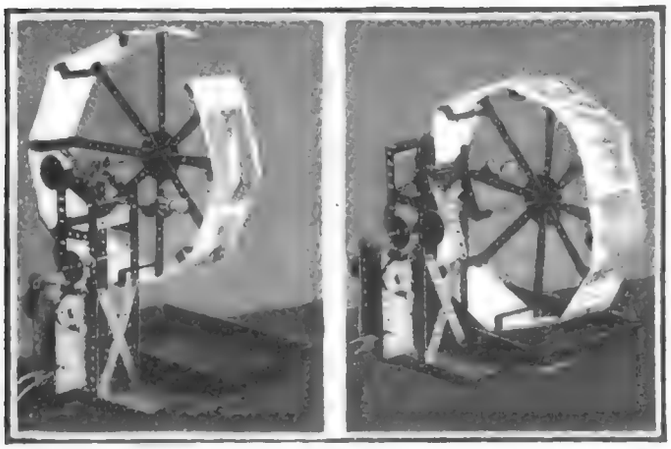
PART V.—DEVELOPING, FIXING, WASHING, INTENSIFYING AND REDUCING NEGATIVES

IN photography those processes are of importance where a photo-chemical substance is changed by light. This change does not necessarily have to be visible; all that is required is that the action of the light modifies the substance sufficiently whereby its resistance to certain chemicals is of an entirely different order from the resistance of those places where no light was received. In these circumstances the action of the light is latent, that is, the virtual image, which is present upon the plate after exposure, can not, as yet, be seen. Silver chloride, silver iodide, and silver bromide are the three main silver halides which play such an important part in photography, and of these the silver bromide is, by far, the most important today, although it is only a modification of this halide which is most eminently adapted for this purpose. The silver bromide has the characteristic property, after it has been exposed to light, of changing its nature chemically and of undergoing reduction when treated with certain reagents. Under the influence of light silver bromide is changed to such an extent that chemical methods will make this change visible. As soon as it is brought under the influence of reducing agents, the so-called *developers*, it is reduced to metallic silver, but this action is primarily restricted to the silver bromide which has been placed under the influence of the light, while the places not struck by light resists this action for some time.

Upon the photographic plate or film this silver bromide is scattered about in an emulsion of gelatin. The gelatin itself is by no means unimportant, for it increases the sensitiveness of the plate. It is a chemical sensitizer which has not, as yet, been ousted by any other body.

When such a silver bromide plate is exposed to the camera the resulting picture on development only approximates the true tone value of the object taken. The portions of the film coating exposed to red light, are but slightly affected, then it increases until the maximum is reached in greenish yellow. From this point it again decreases as blue is approached, while violet is again insusceptible to development. The common silver bromide plates are not sensitive for the greater part of the spectrum, the sensitiveness begins with a light blue and finds its maximum in the invisible dark violet of the spectrum. For this reason the plates give us an image where the parts appearing lightest are too dark, while the dark colors appear too light. These mistakes are not so evident in pictures taken from Nature since pure colors are never found there. The reflected rays carry other colors mixed with those considered primary.

A layer of silver bromide absorbs, through its yellow color, only those rays which lie in the blue part of the spectrum while transmitting yellow, red, and green light which, therefore, produce an effect upon the plate. But the silver bromide can be made sensitive for these colors when substances absorbing these rays are added to the emulsion. Such substances absorbing red are tinted blue, and is absorbed by red tints. Such dyes, mixed with silver bromide, make the plate sensitive for longer wave lengths of light, and are in quite common use, but technically only a few of them serve this purpose. An ideal plate, sensitive to all colors in like proportions has not, as yet, been produced. Substances used today for dyeing emulsion are eosin-halogenated fluorescien—and isocyanine which are halogen compounds of bodies formed by the action of an organic iodide on organic bases. The action of these coloring matters upon silver bromide is catalytic; minute quantities of a dye are sufficient to influence a large quantity of the silver.



The Photos Above, from Left to Right, Are as Follows: The Method of Placing the Film on the Motor-Driven Developing Rack; the Position of the Rack When Development is Being Carried On; Placing the Prints in the Wash Water with the Floating Clips and the Proper Method of Holding the Film When Developing in a Tray.

Sensitol-violet is one of these isocyanine dyes which can be successfully employed for sensitizing the emulsion on film or plate. The solution is very sensitive to acids and must be kept in the dark. A stock solution of the dye is prepared by dissolving one gram of sensitol violet in one liter of wood or grain alcohol. From this the sensitizing solution is prepared by first dissolving two grams of borax in one liter of water, and then adding 20 cc., of the stock dye solution. This should be kept in the dark. Immerse the plate in this bath for four minutes, throw the solution away, wash the plate thoroughly with alcohol, drain and then dry.

Plates treated in this manner, although requiring a longer exposure than ordinary plates, give images approximating to the original in their tone values.

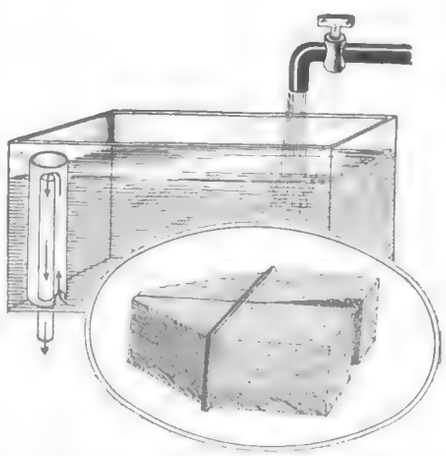
In the dark room the dust free plate is placed in the plate holder, the plate is then exposed for the correct time in the sharply focused camera, and the latent image produced is developed in the dark room by the action of certain chemicals. The pleasure of seeing the picture gradually appear is missed by all who confide the plate to other hands.

The process of development is carried out by splitting off bromine from all those parts receiving light upon the plate and by the decomposition and reduction of the silver sub-bromide by the developer. The chemicals used for the development are those which possess the property of producing this reduction.

To recommend a developer is difficult; if one is used to a certain type, it should not be discarded for another. Every type of developer found on the market will produce good negatives if correctly handled, provided that the exposure was correct.

I have used a hydroquinone developer for more than 20 years. It can be made in bulk and will keep for months, and no other additions need be made before using.

(To be concluded)



The Correct Method for Allowing the Water to Flow Out of a Washing Tank, is Shown Above, While the Insert Shows the Construction of the Cork Clip Which Holds the Prints and Floats Upon the Surface of the Water.

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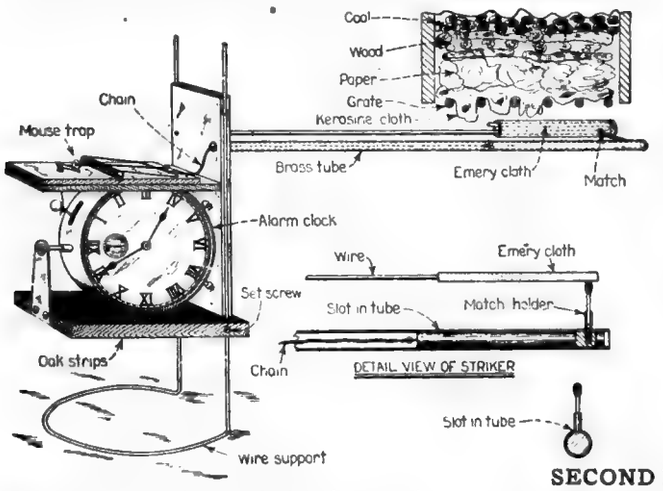
HOW-TO-MAKE-IT

This department will award the following monthly prizes: First prize, $15.00; second prize, $10.00; third prize, $5.00.
The purpose of this department is to stimulate experimenters toward accomplishing new things with old apparatus or old material, and for the most useful, practical and original idea submitted to the Editors of this department a monthly series of prizes will be awarded. For the best idea submitted a prize of $15.00 is awarded; for the second best idea a $10.00 prize, and for the third best a prize of $5.00. The article need not be very elaborate, and rough sketches are sufficient. We will make the mechanical drawings. Use only one side of sheet. Make sketches on separate sheets.

FIRST PRIZE $15.00

LIGHTING FIRES AUTOMATICALLY

In the drawing is shown an alarm clock fire lighting device, which I have built and



A Simple and Useful Scheme for Lighting Fires Automatically, Is Illustrated in the Accompanying Drawing.

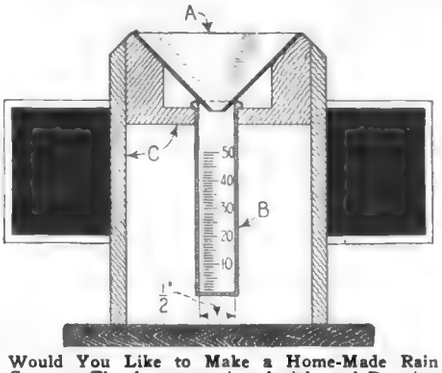
which is a very handy device for people who have to arise early in the morning to start fires. I let my alarm clock start my fire every morning, and I can thus sleep an hour longer. Before retiring at night I put a little paper covered with kindling and coal in the stove, and let a small piece of cloth soaked with kerosene oil hang through the grates on the lighter and I set the alarm, which does all the rest. One of these can easily be made with an old alarm clock. Procure a few pieces of hardwood lumber, cut as shown in the drawing, and put them together with screws. Then obtain a piece of brass or steel pipe fourteen inches long, and slot one end to allow for free movement of the match holder, as shown. To make the match holder get a piece of round metal about one and a half inches long, and have it fit the pipe snugly, then drill and tap one end for a small eyebolt, and on one side near the other end drill another hole to put in a real small pipe, about one inch long, with an opening large enough to hold a match. Then fasten the chain to the match holder, slip the chain into the pipe, and secure the other end of the chain to the trap. Obtain a piece of No. 1 emery cloth, tear off a three inch strip and cut it to fit around a bent wire and stitch emery cloth to the wire. This should fit very snugly. Fasten one end of a fine wire to the alarm hammer of the clock, and the other end to the lever of the trap. This should fit exactly, so that when the lever is up the trap is set and the wire is stretched. A common match is cut so that it fits tightly against the emery cloth. Set the trap, pull back the match holder so that the match rests against the emery, and insert the pipe into the draft below the grate. Care should be taken that a cloth soaked in kerosene hangs right where the match stops after the trap is sprung, and it will light the fire every time. The wire rod stand, to which the apparatus is secured, permits it to be raised or lowered to fit the draft of different stoves.

Contributed by EDWARD J. KELNHOFER.

SECOND PRIZE $10.00

AN EASILY CONSTRUCTED RAIN GAUGE

Most of the necessary information needed in the construction of the rain gauge is



Would You Like to Make a Home-Made Rain Gauge—The Accompanying Article and Drawing Show How to Do This.

given in the illustration. A is a funnel, or the cone of a funnel, and is best constructed of copper, to stand errosion, although galvanized iron will do. A glass funnel may be substituted. B is a small cylindrical, flat-bottom bottle. The builder used a bottle that Eastman developer came in. The scale of measurement is pasted on the bottle. To determine the scale: First measure the diameter of the top of the funnel and the diameter of the bottle and find the ratio of the squares. This gives the height to which one inch of rain will fill the collecting bottle. For example, supposing the funnel was 80 mm., and the bottle 20 mm. 6400/400 = 16/1. Therefore, in this case, one inch of rain would fill the bottle sixteen inches. Then this particular scale would be sixteen inches long, which is divided into one hundred parts, as rain is measured in tenths and hundredths of an inch. If the bottle is not long enough, only half the scale need be put on. C is a wooden support made of any kind of wood. It should be well painted to stand the weather.

This gauge should be placed in a clear open place, away from tall objects. A fence three feet high at a distance of three feet from the gauge will give protection from the disturbing elements.

Where it is inconvenient to take the measurement every few days, a large bottle may be substituted for the small one and the small one used as the unit of measure.

Rainfall is always expressed in fractions of an inch, and the following parts will graphically illustrate its effects, both in weight and volume, upon the earth's surface. An imperial gallon of water weighs ten pounds, and if spread out in a layer one inch thick will cover an area of approximately two square feet. An inch of rain gives 100 tons of water to the acre, or nearly 60,000 tons to a square mile.

Contributed by CARLYLE WEISS.

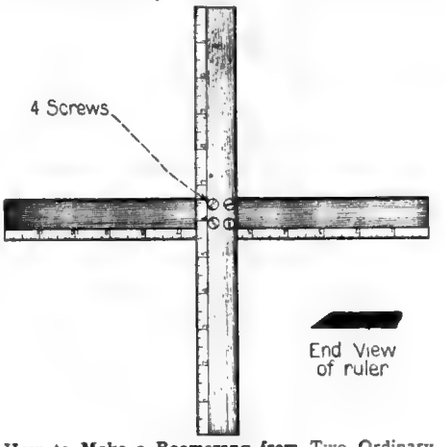
[*The exact weight of an American gallon of water at 62° F. is* 8.3356 *lbs. and one inch of rain falling on a square mile of land weighs* 57,428.0832 *tons at 62° F.*—ED.]

THIRD PRIZE $5.00

THE RULER BOOMERANG

I have been experimenting with boomerangs for a long time, and have made boomerangs of all descriptions, but the best yet was made from two similar rulers. These rulers should have about the same bevel as in cut. If you have rulers with metal edges, remove the metal. The two selected rulers are screwed together as shown in Fig. 1. After the boomerang has been constructed go out in an open field and try it. Hold it in your right hand, on one end of one ruler with the numbered sides up. Throw it on a slant of eighty degrees with a moderate force. Be sure that it spins. If there is a slight breeze throw your boomerang against it, but on a slant, slightly steeper than eighty degrees. On a still day with a little practice you will be able to make the boomerang come back. When you become more expert you will be able to catch it as it returns. Boomerang throwing furnishes much fun for boys and even men. See if you can be the first one to start the boomerang hobby in your town.

Contributed by JAMES B. SNIFFEN.



How to Make a Boomerang from Two Ordinary Desk Rulers.

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Wrinkles, Recipes, Formulas

EDITED BY S. GERNSBACK

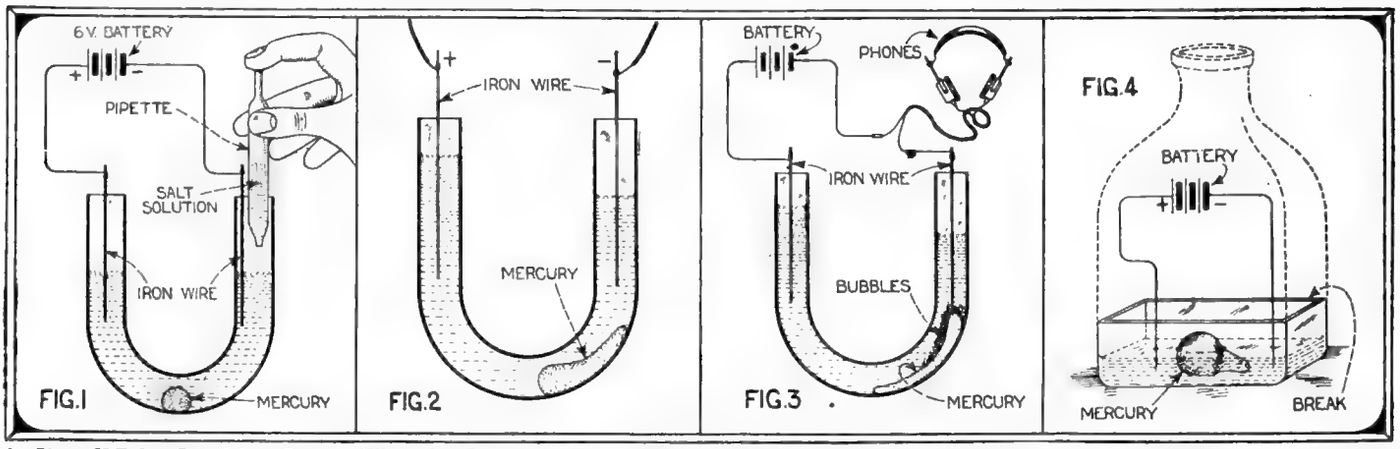
THIS MONTH'S $5.00 PRIZE

A NOVEL ELECTRO-CHEMICAL EXPERIMENT

By John Parkin, Jr.

Experiments regarding the movement of mercury in a conducting liquid traversed by an electric current.

Some years ago I was experimenting with the capillary relay and, not being satisfied with the explanation given in most books that its action is dependent on the fact that the mercury follows the electric current, I made a series of experiments on the movement of mercury in different electrolytes and got some interesting but mystifying results.



A Glass U-Tube Containing Two Iron Terminals Connected to a Suitable Source of Current and a Drop of Mercury, is Filled with Salt Solution from a Pipette.

When the Current is Turned On, the Mercury Elongates and Tends to Move Toward the Negative Pole, While the Solution Moves in the Opposite Direction.

This Tendency of the Mercury to Move Toward the Negative Pole is Quite Marked Even When Using a Current as Small as One Two-Thousandth of an Ampere.

The Same Experiment Tried, Using a Glass Trough, Made by Cutting off Part of a Bottle, Gives a Similar Result. A Small Foot Seems to Grow from the Side of the Mercury Globule.

Apparatus: A U tube of glass, about ⅛" inside diameter; a globule of mercury; two flexible wires with pointed iron terminals, a storage battery or dry cells giving about six volts, and a salt solution.

Place a drop of mercury in the center of the glass U tube and with a pipette drop a saturated salt solution into both ends of the tube. Place the iron terminals in the upright portions of the tube deep enough to enter the electrolyte and connect the battery to the other end of the wires.

Results: The mercury elongates and moves towards the negative pole, but does not usually reach it. The solution tends to move in the opposite direction to that of the mercury, i. e., when the mercury is moving to the right the height of the solution in the right leg of the tube becomes lower and in the left leg becomes higher. This is just opposite to the action that would take place if the mercury was moving the solution with it, and seems to indicate that a force, acting at the contact between the mercury and solution, tends to move the mercury in one direction and the solution in the opposite.

If the negative pole is now lowered so as to touch the mercury, the globule elongates still more into a streamline shape, the small end adhering to the terminal. The mercury bubbles and gives off a reddish brown substance. If the negative pole is moved suddenly away from the mercury, but left in the solution, the globule rushes to the positive pole and often moves spasmodically back and forth until it comes to rest. This appears to be caused by the mercury collecting bubbles during its passage through the solution. A film will be noticed to snap from one end of the globule to the other as it reverses its direction. After the mercury has touched the negative pole, the positive pole being in the solution, it will never pass from positive to negative again as it did at first, but will always move from negative to positive. The tendency of the mercury to move may be noticed with the naked eye when using a current as small as one two-thousandth of an ampere. This current is easily procured by using a pair of 2000 ohm phones as a resistance in series with a one volt battery.

Apparatus: A glass trough ⅛" deep and ⅛" wide about two inches long. Other apparatus the same as in experiment No. 1.

The trough may be made of a small rectangular bottle broken longitudinally and set on its side.

This apparatus, while giving the same results as the U tube, allows a few more experiments to be made on account of the accessibility of the mercury and solution.

A saturated solution of salt water is placed along the length of the trough about one-sixteenth inch deep, a drop of mercury ⅛ inch diameter is placed in the center of the trough. The top of this will, of course, be out of the solution. All the experiments that were made with the U tube will, when repeated with this apparatus, give the same results.

If both terminals are now placed on opposite sides of the mercury, and equally distant from it, the mercury moves towards the negative pole. Now, with the negative terminal in the solution, touch the positive terminal to the mercury. It becomes dull colored, sluggish, and will stay dented if touched and will not regain its globular form of itself as mercury will usually do. This result is also obtained if the experiment is tried as soon as the mercury is put in the trough. If the terminals are now placed in the solution on opposite sides of the mercury it will not move or change its color unless mechanically shaken. If this is done it moves towards the negative pole. If before this is done the positive terminal is placed in the solution and the negative terminal touched to the globule of mercury it immediately regains its luster and assumes a streamline form, straining to reach the positive pole, but held (probably by adhesion) to the negative terminal. When released by shaking it from the negative terminal, it rushes to the positive terminal and, if it has been in contact with the negative terminal for several seconds before being released, oscillates back and forth between the two poles until, some apparently stored energy being expended, it comes to rest and slowly moves to the positive pole.

Another phenomenon which seems to indicate stored energy is that, if after the mercury has been in contact with the negative terminal until bubbles are formed and the solution has started to become reddish brown, both terminals are entirely removed, the mercury moves spasmodically back and forth in the solution as if gathering and dispersing a static charge from the bubbles.

It will be remembered that when the mercury was first placed in the solution it moved from positive to negative, but after having touched the negative terminal it moved from negative to positive. To test whether the change which had taken place was in the mercury or the solution a new drop of mercury was placed in the old discolored solution. This moved first to the negative terminal and having touched it always moved from negative to positive. This seems to show that the change is in the mercury and not in the solution.

If a fresh drop of mercury is added to the one that has been used and which travels towards the positive pole, the large resulting globule lengthens out and part of it tends to go to each pole, but it does not actually separate on account of the cohesive force, or perhaps I should say adhesive force as a chemical change seems to have taken place and the two drops seem to be almost different substances.

When nitric acid is used instead of the salt solution the action is simple, the mercury always moving from positive to negative. When the mercury is touched with the positive pole it gives off more bubbles than when touched with the negative. It does not become dead when either pole touches it. A mixture of salt water and nitric acid causes the same effect on the mercury when traversed by a current, as the nitric acid solution.

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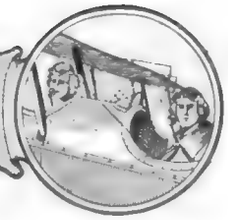
RADIO DEPARTMENT



Broadcasting Complete Operas

By LLOYD JACQUET

TO the radio fan, comfortably receiving a concert or an opera from a station hundreds or even thousands of miles away, little is known of the wonderful mechanism behind the scenes.

Concerned primarily with the tuning and adjustment of his receiving, he little realizes the skill and knowledge which bring about this modern miracle—"opera at home in an easy chair."

It was from the pioneer broadcasting station WJZ, located on top the Westinghouse Electric plant in Newark, N. J., that the first complete opera was sent out.

Early in the month of March, the Wagnerian Festival Company, just arrived from Germany, began a series of the popular Wagner Opera in New York City. The broadcasting of these operas by radio was to be not only a test of the popularity of opera broadcasts as far as the fans were concerned, but also a test as to whether radio broadcasting would have any influence upon the theater box-office receipts.

The Wagnerian operas are very long. They range between three and four and a half hours. They are also noteworthy for their large choruses and their long and ponderous overtures. It will be readily understood, then, why the feat involves some big problems, and constitutes a real test in broadcasting.

Station WJZ was unusually well situated and equipped to attempt such a test. It is the oldest station in the metropolitan district, and has been completely overhauled. It has a power output of 1 k. w. and has an extreme range of several thousand miles.

Engineers and operators at the station were well qualified to attempt the experiment, which was looked upon as an impossibility by many. How successful it proved to be is told in the comments of the press throughout the country.

The WJZ staff was experienced in "picking up" work. That is, its members knew from experience how to pick up signals which were to be sent over wire to the broadcasting station for transmission from there. It will be remembered that many of the reports of football and baseball games were sent out *via* WJZ.

While the general principle is the same with the broadcasting of operas, the latter process entails a nicety of adjustment and operating which can be carried out only after extensive study of the problem by men of experience.

The problem was tackled with typical aggressiveness, and on the evening of February 20, practically without notice, except for the brief opera synopsis by the announcer, "The Flying Dutchman" was presented to a startled and agreeably surprised radio audience. The success of the first broadcast was such that it was quickly followed by the presentation of "Die Walkuere," "Die Meistersinger," "Lohengrin," "Tannhaeuser," and others. These operas were picked up in Cuba, in far points of Northwestern Canada, and in Bremerhaven, Germany. The success of the experiment was assured. Radio broadcasting of opera was accepted and applauded by the radio fan. It was another victory in the pioneer work of the oldest station of this part of the country.

Let us now go "behind the scenes" in broadcasting. The mechanism which converts the sound waves into electric impulses and conveys it to the listeners' apparatus is comparatively simple, but very interesting.

A typical case is the installation for the most popular of the Wagnerian operas—"Tannhaeuser"—from the Lexington Theater in New York, via WJZ, on March 15, 1923.

Before the performance, the microphones which are to pick up the sound vibrations are carefully located and placed. A knowledge of the stage acoustics and of the opera is very necessary. The microphones, three in number, must be so located as to pick up every sound made, either by the orchestra, soloists, or choruses. They must be judiciously placed so that the sound will not be too strong, or too weak, as the actors move about.

One of the microphones is placed under the stage, in front of the prompter's box,

(*Continued on page* 65)

Broadcasting Complete Operas from the Well-Known Westinghouse Radiophone Station, WJZ, located at Newark, N. J., Has Been Successfully Accomplished After a Little Experimentation in the Proper Placing of the Microphones or Sound Collectors on the Stage. In the Accompanying Picture the Schematic Details of the Telephone and Radio Circuits Employed in Picking Up and Transmitting the Voices and Orchestra Music at the Theatre in New York City Are Shown; The Telephone Currents Then Passed Under the River via Telephone Cable to the Newark Radio Station, From Which Point the Opera Was Broadcasted via Etheric Waves in All Directions for a Distance of Several Thousand Miles. Three Special Microphones Are Used, One on Either Side of the Prompter's Box, and One to the Rear of It Facing Toward the Orchestra in Order to Pick Up the Music from the Latter. One of the Insert Photos Shows the Announcer and Voice Amplifier Instrument Situated Just Below the Theatre Stage.

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Above is Shown the Apparatus in the Office of the Chief Radio Inspector of the Port of New York, Located at the Customs House in New York City. In the Lower Left Hand Corner Directly in Back of the Tape Recorder, is Located the Radio Frequency Oscillator, Which Supplies the Current for the Code Tests. To the Right of This May Be Seen the Omnigraph, or Automatic Transmitter, with Which the Code Tests Are Given. On the Extreme Right in Front of Assistant Radio Inspector Bogardus, is Shown the Wave-Meter Which Is Used for Checking Up on the Transmitting Wave-Lengths of Various Ameteurs and Transmitters in the Vicinity. This Is Used in Connection with the Receiving Set Shown in the Center.

Mr. Batchellor is Shown Above Giving a Confidential Talk to the Prospective Amateurs, Outlining to Them the Various Duties and Obligations They Undertake When Erecting a Transmitting Station, and Urging Them to Instill in Others the Spirit of the Game. This Talk is a Part of Every Amateur-License Examination. To the Right are Shown the Amateurs Taking the Speed Test Which is Part of the License Examination. They are Required to Receive at the Rate of 10 Words per Minute Accurately in Order to Obtain a First Grade Amateur Liecnse.

Obtaining an Amateur Radio License

YEARS ago there were but two distinct classes of personages in the radio field, the *amateur* and the *professional*. The amateur was one who entered the game for the fun of it, or to utilize his own knowledge, while the professional, of course, was the radio operator aboard ship or ashore, who made his living by "pounding brass."

The events of the past two years have introduced a third class, the *broadcast listener*. His number is legion and it may be expected that every home in the country will be equipped with a receiving set in a short time. Still the amateur persists and continues to grow in spite of the persecutions visited upon him by the broadcast fans —some just, some unjust.

Some of the latter, after tiring of the usual round of lectures, jazz and sermons, turn to the more interesting phase of radio —transmitting. Here they encounter various mysterious phenomena, and for the first time find themselves compelled to obey certain specified radio laws, as well as to obtain a license. The latter is usually a stumbling block, for a good many of the latter-day amateurs desire to use radio telephone transmission. However, they are informed that they must obtain a regular license for this work and must be able to transmit and receive radio telegraph messages accurately at a speed of not less than 10 words a minute. They also find that they can only carry on conversation between amateurs and that they must not use their transmitter for broadcasting music, news and other items as is done by licensed broadcasting stations.

If they are persevering they attain their goal and apply at the nearest radio inspector's office for examination. The office taken as our model is that of Arthur Batchellor, Chief Radio Inspector of the Port of New York, located in the Customs House, New York City, and shown in the accompanying photographs taken by our staff photographer. Mr. Batchellor has inaugurated several novel points in his examinations for the amateurs, which, in the editor's opinion, are excellent.

The usual procedure in the examinations is a code test; a written examination which brings forth the applicant's knowledge of the adjustment and operation of the apparatus he is to use, and of the regulations of the International Convention and Acts of Congress, in so far as they relate to the particular applicant, and last, but by no means least, a confidential talk to the embryo operator by the Chief Radio Inspector.

The latter is very important, inasmuch as it presents to the amateur in a logical manner just exactly what his duties and obligations are. Mr. Batchellor touches upon the moral, legal and technical obligations, showing the amateur how the government is always backing him up and ready to aid him, until he wilfully infringes upon the laws of his country. The fact is also brought out that no other country in the world is as lenient with its amateur radio operators as is the United States, it being one of the few countries in which amateurs may even operate a transmitter.

After his talk, Mr. Batchellor has one of the applicants read the ten radio commandments, which are embodied in the amateur's license, thereby impressing them vividly upon the minds of the others present. The license embodying these regulations runs as follows:

PURSUANT to the act to regulate radio communication, approved August 13, 1912, ..., age....., a citizen of the State of....., County of....., City or town....., Street....., No....., having applied therefor, is hereby granted by the Secretary of Commerce, for a period of..... year , on and subject to the restrictions and conditions hereinafter stated and revocable for cause by him, this License to use or operate the apparatus for radio communication (identified in the Schedule hereinafter) for the purpose of transmitting private radiograms or signals, notwithstanding the effect thereof, extends beyond the jurisdiction of the State or Territory in which the said station is located: PROVIDED, That no interference other than may result under the restrictions contained in this License shall be caused with the radio communication of stations of the Government of the United States or licensed stations.

2. The use or operation of apparatus for radio communication pursuant to this License shall be subject also to the articles and regulations established by the International Radiotelegraphic Convention, ratified by the Senate of the United States and caused to be made public by the President, and shall be subject also to such regulations as may be established from time to time by authority of subsequent acts and treaties of the United States.

(*Continued on page* 86)

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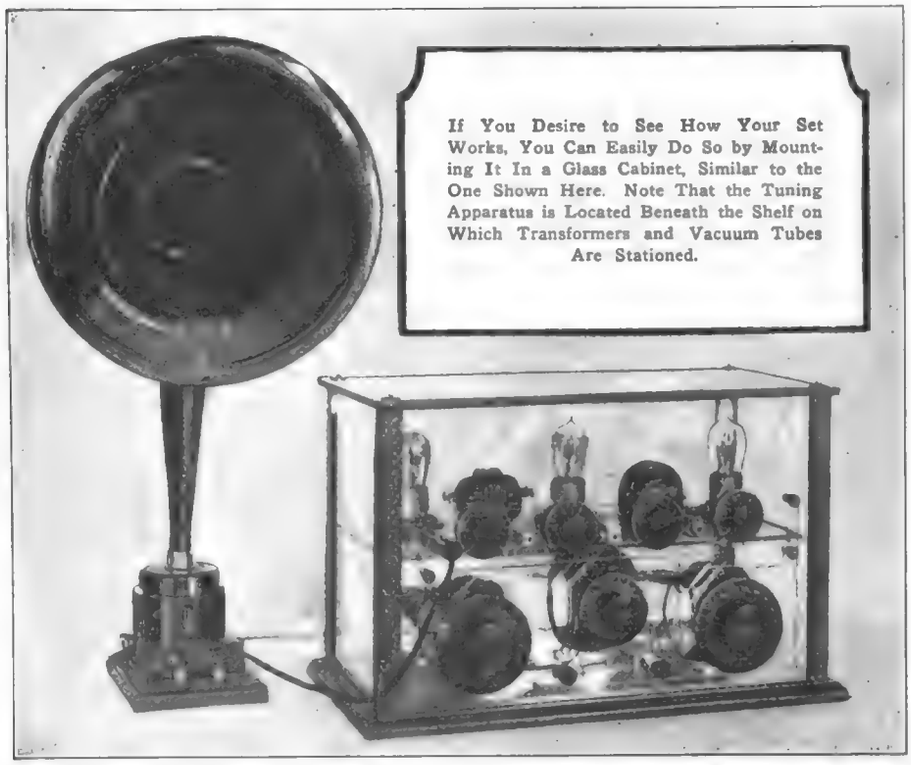
All Glass Radio Cabinet



If You Desire to See How Your Set Works, You Can Easily Do So by Mounting It In a Glass Cabinet, Similar to the One Shown Here. Note That the Tuning Apparatus is Located Beneath the Shelf on Which Transformers and Vacuum Tubes Are Stationed.

An idea to overcome some of the objectionable noises in a radio receiving set which is to be patented is included in this unusual home-made outfit, built in a plate glass case by an amateur who is at present working on several other improvements. He used the plate glass solely with an idea of being able to watch the operation of the outfit. Programs, concerts and news bulletins have been picked up from virtually all of the big broadcasting stations in the United States. This set was built by Edward Gerling.

The designer believes that his idea, a very simple contrivance, will eliminate all noises when perfected. In comparing it with others he has been able to "listen in" when friends were unable to get the waves.

He used a crude set of tools to build the set, drilling eighty-two holes at different places in the glass. The case is large enough for all parts, including the "B" battery. The case is dust-proof, felt strips being used at the edges of the glass. Fiber washers are used at places where perforations are made through the glass.

The method of drilling the glass was not very difficult, but required patience. Marking the holes can be accomplished by chalk or a sharp file, which will scratch into the plate-glass surface.

The case may be taken apart in a few moments. Four taps hold the top in position. The sides are adjusted in wood with grooves at the proper angles. The outfit cost $150.00 to build.

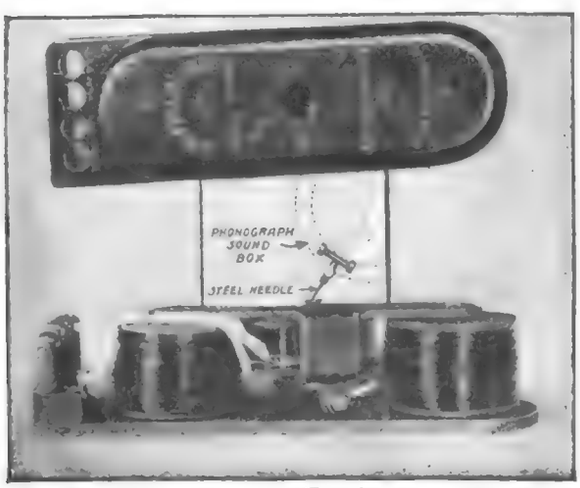
Phonograph Loud Talker

A NOVEL loud-talker that utilizes the diaphragm and horn of an ordinary phonograph has recently been put on the market by a California firm. These parts of phonographs have been developed in a very high degree and lend themselves very well to the amplification of the music and voice received on a radio set.

Primarily the loud-talker consists of three coils and a moving plate. Two of the windings are connected in series and joined to a source of current supplying six volts. These furnish the magnetic field which is conducted to the core of the other coil by soft iron strips, where it acts on the moving vane. The base of the instrument comprises the return magnetic path.

As may be seen from the accompanying photograph, there is a smaller winding situated between the two field coils. This is connected directly to the plate circuit of the last amplifying tube in the same place where the phones are normally connected. No step-down transformer is necessary in the circuit, as the resistance of the small coil is sufficient to enable the instrument to work properly. Placed within this small coil is a thin rectangular soft steel vane, on the upper end of which is a small projection turned at right angles to the vane proper, and grooved on its upper surface. This may be seen plainly in the photograph. The lower end of the vibrating vane is held in position by a phosphor bronze wire which is adjustable by means of two machine screws. This phase of the construction is very similar to the well known Baldwin phone.

The action of this instrument is as follows: The field coils, by magnetizing the iron strips, produce magnetism in the vane. The incoming signals vary the magnetic field of the small coil, and produce corresponding variations in the vane, causing it to vibrate.



No Change in Your Phonograph is Necessitated in Employing the Radio Loud-Talker Here Illustrated.

In use the instrument is placed on the turn table shelf of any phonograph with a reproducer capable of playing lateral-cut (Columbia, Victor, etc.) records. It is located so that the groove in the projection of the vane will be parallel to the face of the reproducer. The instrument is then connected to a source of field current, which may be the regular A battery, and to the receiving set. The needle of the reproducer is then placed in the groove provided for it and the instrument is ready to reproduce music and voice.

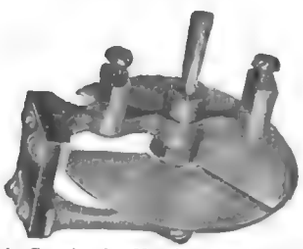
Vernier Condenser

NEW VERNIER CONDENSER

Herewith is illustrated a new adjustable vernier condenser for fine tuning of radio receiving circuits. Among its features are the following:

Adjustable air gap, insuring correct setting for maximum capacitance, adjusted to the main condenser with which it may be used. New type of bearing, noiseless in operation. Elimination of contact springs. Non-magnetic material used throughout.

Owing to the condenser's adjustable air gap, which can be set within wide limits, its maximum capacitance, of course, depends upon how closely the vanes are set. If care is used in this setting a capacity as high as .00005 microfarad can be obtained.



The Air Gap in the Vernier Condenser Above Shown, May Be Adjusted So That a Very High Capacity Can be Obtained.

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The Shortest Radio Waves

By DR. E. F. NICHOLS* and J. D. TEAR

THE shortest radio or electric waves ever obtained have just been generated and measured in the *Nela Research Laboratories* of the *National Lamp Works*, Cleveland, Ohio, where waves as short as 1/100 of an inch have been isolated. Thus, the last link of a long chain of experimental evidence connecting light with electric waves has been forged. Light waves and radio waves are now known to differ only in length.

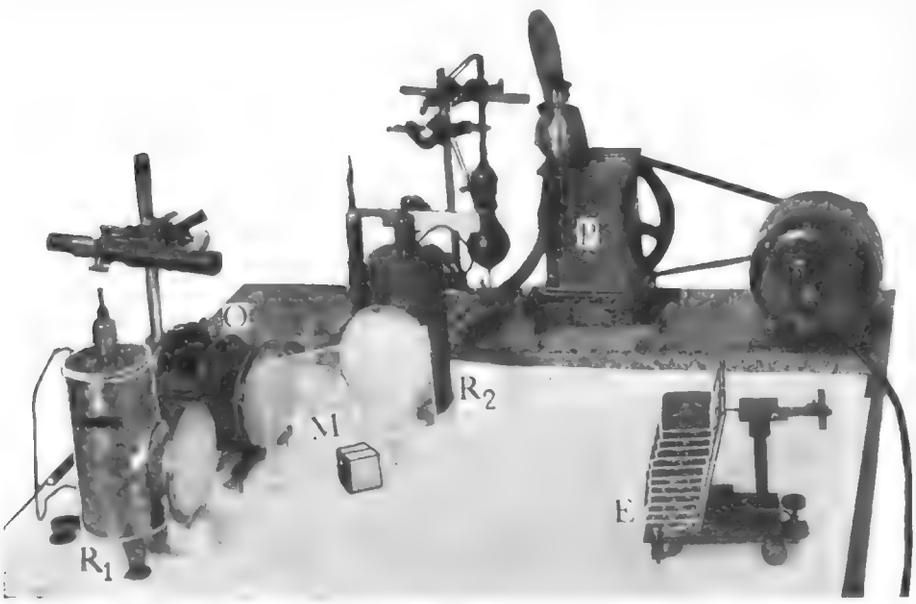

Fig. 1. General View of Short Wave Apparatus Set Up in Laboratory, as Used in Making Researches by Dr. E. F. Nichols and Mr. J. D. Tear. A Motor Driven Vacuum Pump is Seen in the Background for Exhausting the Air from the Short Wave Transmitter and Receiver, etc. The Apparatus E, is an Echelon Wave Analyzer; the Transmitter Appears at O, a Check Receiver at R2, and the Main Receiving Instrument at R1.

Nearly sixty years ago, when James Clerk-Maxwell announced his epoch-making theory, that light waves were electric waves; the chief difficulty in understanding and establishing the new theory, was that we had no electric waves, and the possibility of getting any seemed shadowy and very remote; yet twenty years later, Hertz actually generated electric waves and performed a number of experiments to show that electric waves, like light waves, were reflected from surfaces, refracted by prisms, could be polarized, and both traveled through space with the same velocity. His shortest waves were about two feet long.

Hertz's followers divided into two groups. Righi, the eminent Italian physicist, and a number of others worked toward shorter and shorter waves and performed more and more experiments to show the similarity of behavior between electric waves and light waves. Through the limitations of instruments and methods these investigators were finally brought to a halt in their progress toward short waves at wave-lengths between 1/3 and ¼ of an inch and could go no further.

The other group of investigators, more practical minded, were led by Sir Oliver Lodge, and sought to utilize the newly discovered electric waves as a means of signalling and communication. These scientists and engineers worked toward longer and longer waves, for longer waves have greater carrying power and are not so easily stopped by obstacles such as hills, buildings, forests, etc. Of this group, the brilliant young Italian, Marconi, was the first to succeed and out of his success came *radio telegraphy* and, after the advent of the audion amplifier, came the greater marvel of practical *radio telephony*.

During this progress with electric waves, physicists working from light waves toward longer and longer wave-lengths down through the infra-red or heat spectrum had finally reached heat waves 1/75 of an inch long. When the present experiments were undertaken, there were no known waves between 1/75 and ¼ of an inch in length.

For any substantial progress toward shorter electric waves, new and improved instruments and methods had to be devised. The arrangement of apparatus used in the new experiments is shown in Fig. 1. The Hertzian oscillator or sender is contained in a brass box. The oscillator is a point source, and the diverging wave pencil emerging from it is formed into a parallel beam by a lens of paraffin wax. At R_2 with a similar lens in front of it is a check receiver. Waves emitted by the sender first fall on a glass plate M and are partially reflected into the check receiver. The remaining portion passes through the glass and falls upon the reflecting echelon analyzer at E. This analyzer is a flight of small steps, made of exactly equal brass blocks, which rest against a tilted glass plate, which serves to keep them in line. The tread of the steps can be made wider or narrower by known amounts by adjusting the micrometer screw which presses against the top of the glass plate. By this means it is possible to measure the wave-length of the electric waves and also to determine the form of the short wave trains emitted by the oscillator. From the face of this echelon analyzer the beam of electric waves is reflected back to the main receiver R_1. A motor driven vacuum pump for exhausting the air from the two receivers is seen at P in the background. The check receiver R_2 serves simply as a control upon the intensity of the beam emitted by the oscillator, so that any erratic changes of emission may be recognized and corrected.

In a sectional diagram of the oscillator shown in Fig. 2 the various essential parts are as follows: B is a brass case containing kerosene; T_1 and T_2 are glass tubes in which very small cylinders of tungsten, H_1 and H_2, are sealed. These tungsten cylinders separated by a short spark gap in kerosene form the Hertzian doublet which emits the short wave radiations. High potential leads, V_1 and V_2, charge H_1 and H_2, by leakage across air gaps, G_1 and G_2, until H_1 and H_2 build up sufficiently high potential differences to break down the kerosene insulation in the spark gap, G. The ensuing electrical oscillations between H_1 and H_2 are the source of the electric radiation. Waves emerge from the oscillator case through the circular mica window, W, and falling on the paraffin lens P are formed into a parallel beam. M is a concave metal mirror behind the doublet to reinforce the issuing beam by reflecting the backward emission of the oscillator. For simplicity, many necessary details such as fine adjustments for regulating length of the spark gap, G, etc., are omitted. The wave-lengths emitted by the oscillator depend on the length and diameter of the tungsten cylinders, H_1 and H_2. For the shortest wave generated, these cylinders were 1/250 of an inch long by 1/250 of an inch in diameter.

The type of electric wave receiver employed was a newly designed modified radiometer making use of a curious temperature effect in rarefied gases discovered fifty years ago by Sir William Crookes. He found that if a thin plate, warmer on one face than the other, is mounted in an enclosure from which nearly all of the air has been pumped out until only 1/15,000 part remains, then the pressure of the residual gas is slightly greater on the warm side of the plate than on the cold.

To illustrate this effect, Crookes designed the little radiometer or light mills often seen revolving in glass bulbs in opticians' show windows. To utilize this effect in a very sensitive electric wave receiver, the instrument shown in the cross-sectional diagram Fig. 3 was constructed. A greatly enlarged diagram of the suspended receiver system is shown at A. D is a very thin whip of drawn glass bearing two similar glass cross arms, EE. To these are attached two very thin mica strips, V_1 and V_2, and just in front of V_1 and behind V_2 are mounted narrow mica strips, P, coated with

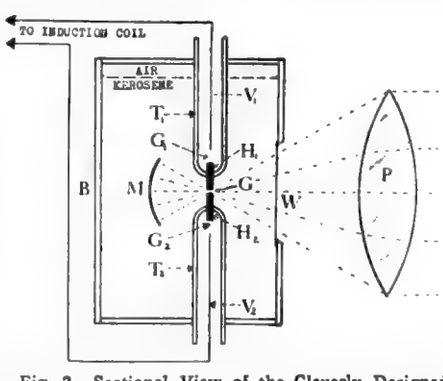

Fig. 2. Sectional View of the Cleverly Designed Short Wave Transmitter. The Short Tungsten Electrodes H1 and H2, Are Charged Through Spark Gaps G1 and G2. The Waves Are Reflected by M, and Focused by the Paraffine Lens P.

*Dr. Nichols is director of the Nela Research Laboratories, Nela Park, Cleveland.

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very thin deposits of metallic platinum. When electric waves fall on metal conductors, they cause very small oscillatory electric currents in the surface layer of the metal. Such thin metal coatings as P possess high electrical resistance. Hence these oscillatory currents generate minute quantities of heat which in these experiments raised the temperature of P by amounts

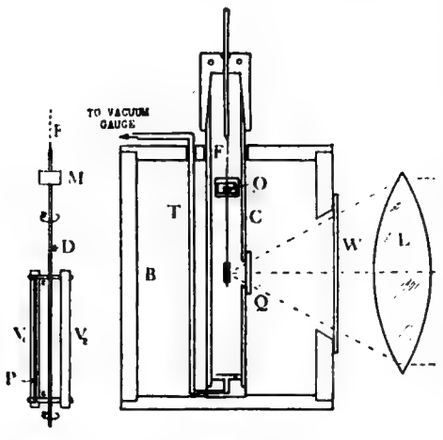

Fig. 3. Sectional View of the Specially Designed Short Wave Receiver Employed in These Exceptionally Interesting Experiments by Dr. Nichols and Mr. Tear. A Reflecting Mirror, M, is Mounted on the Suspended Moving System on Which the Rays Are Focused, the Active Turning Element Being Composed of Two Thin Mica Strips V1 and V2, in Front of Which Are Two Other Narrow Mica Strips P, Coated with Thin Deposits of Platinum. The Heat Generated in These Platinumized Strips by the Incoming Waves, Causes the Moving System to Rotate.

roughly of the order of 1/1,000,000 of a degree. The resulting increased gas pressure on the warmed metal sides of the veins, V_1 and V_2, tends to rotate the system in the direction shown by the arrows. The suspension also carries a very thin glass silvered mirror, M, by which the rotation of the system can be measured. This suspension complete, weighing about 1 mg. or about 1/30,000 part of the weight of a two cent letter, is hung on a very fine fibre of spun quartz, F, from a central stem in the double walled brass case, C and B. From the inner case, C, the air can be exhausted through the tube, T. This case has two window openings, one covered by a quartz plate, Q, admitting the electric waves, and the other, O, through which the rotations of the suspension can be measured, is glass covered. The outer case, B, has corresponding openings and the beam of the electric waves is focused on the vanes V_1, V_2, of the suspension by the paraffin lens, L. The forces due to the resistance heating of the electric waves which rotate the suspension are opposed by the resulting twist of the quartz fibre, F. The angle of twist of the fibre under proper conditions is found to be proportional to the intensity of the electric wave radiation and thus the measurements of wave intensity are made.

With the instruments described we have been able to get successively shorter and shorter electric waves down to a wave-length of 220 microns or a little less than 1/100 of an inch. As heat waves 1/75 of an inch have already been obtained from a quartz mercury arc, we have not only brought the electric wave spectrum and heat spectrum together but have overlapped them. Furthermore, we used our electric wave receivers to remeasure the wave-lengths of the heat waves from the quartz mercury arc and found them identical in character with our shortest electric waves. From the longest heat waves to visible light waves, there is no break, and from light waves on to ultra violet, X-rays and gamma rays from radium, the essential differences are only differences in wave-length and the corresponding number of waves per second or frequency.

The whole electric wave spectrum is shown as a chart in Fig. 4. The chart shows some surprising things, foremost among which is the very narrow restriction of our vision which enables us to see only the very small fraction of the great electric wave spectrum indicated by the black spot. This restriction of vision would have been even more apparent had wave-lengths instead of logarithms of wave-lengths been used in plotting the chart. For then, if the visible spectrum had been shown ¼ of an inch long, to show the longer wave regions of the spectrum out to radio waves would have required a strip of paper four times as long

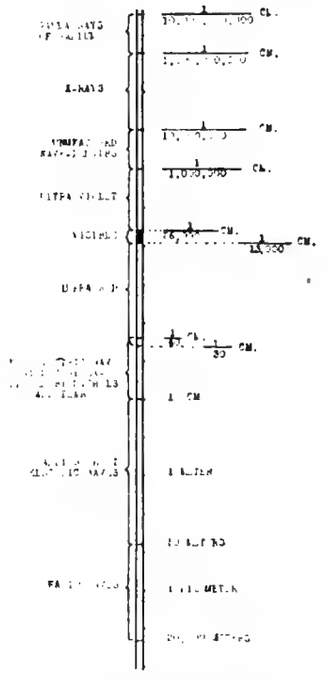

Fig. 4. This Chart Shows the Whole Electric Wave Spectrum. The Black Spot Shows the Very Narrow Restriction of Our Vision Which Enables Us to See But a Small Fraction of the Vast Electric Wave Spectrum.

as the circumference of the earth for their representation, and the newly discovered waves would occupy a length 20,000 times that of the visible spectrum. A 20,000 meter radio wave is 20 million billion times as long as a short gamma wave, but both and all the wave-lengths between are electric waves.

Plug-in Switches for Radio Sets

The radiophone fan who likes to make his own apparatus can build a set of plug-in switches for quickly attaching head sets, extra apparatus and the like, out of some discarded brass cartridge shells and some spring brass.

Saw the shells off so they are about 1/16 inch longer than the thickness of the panel upon which you wish to mount them. Drill holes the same size as the outside diameter of the shell and then push the shell through the holes thus formed. In the case of a base board, have the open end of the shell at the top.

The plug is made of a strip of spring brass bent as shown, and one wire soldered to the outside of the bend. Solder the other wire to the head of the shell.

If the shell fits loosely in the hole secure it in place by driving two tacks, one on either side of the shell so that the heads bear against it.

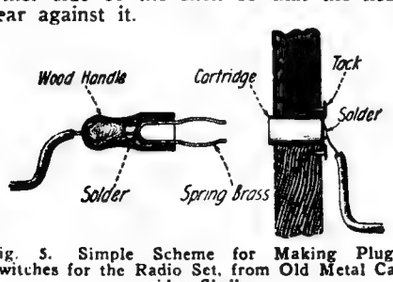

Fig. 5. Simple Scheme for Making Plug-in Switches for the Radio Set, from Old Metal Cartridge Shells.

By means of a steel tool the lip of the shell may be bent out, securing it in place. Turning the lip inwardly will secure the plug more firmly.

Contributed by L. B. ROBBINS

NEW YORK HAS TROLLEY RADIO

The Third Avenue Railway Company of New York City announced that a system of communication by radio carrier current or *wired wireless* was being installed on its trolley lines in the Bronx by the General Electric Company. A successful demonstration of the use of the carrier current was held on March 26th.

"I believe this is the first time this has been introduced in a trolley system on a considerable scale for practical use," said Garrow T. Gear, Secretary of the Third Avenue Railway System. "This will enable employees to communicate with the offices by carrier current from trolley cars, sub-stations and the dispatcher's office."

A SIMPLE DIAL VERNIER

A simple and very efficient vernier for use with any kind of a dial may be quickly constructed at home without any cost.

The only articles needed are one lead pencil and a piece of tape. Sharpen the pencil to a point and fold the tape lengthwise; then proceed to wrap the tape around the pencil near the point, until it is about ⅛ of an inch thick.

Drill a ¼-inch hole in the panel, the center of which should be about ¼ of an inch from the edge of the dial. It is best to have the hole at the bottom of the dial.

The vernier is now ready for use. Place the point of the pencil in the hole as illustrated, and hold by the other end. Raise the end held by the hand, so that the tape bears tightly against the dial. Adjustments can now be made easily, for, by turning the pencil one degree the dial moves but a fraction of a degree.

Contributed by PARK M. ROEPER.

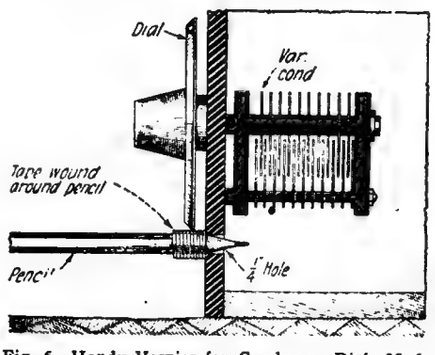

Fig. 6. Handy Vernier for Condenser Dials Made from a Lead Pencil, and a Piece of Friction Tape.

A Simple Dial Vernier

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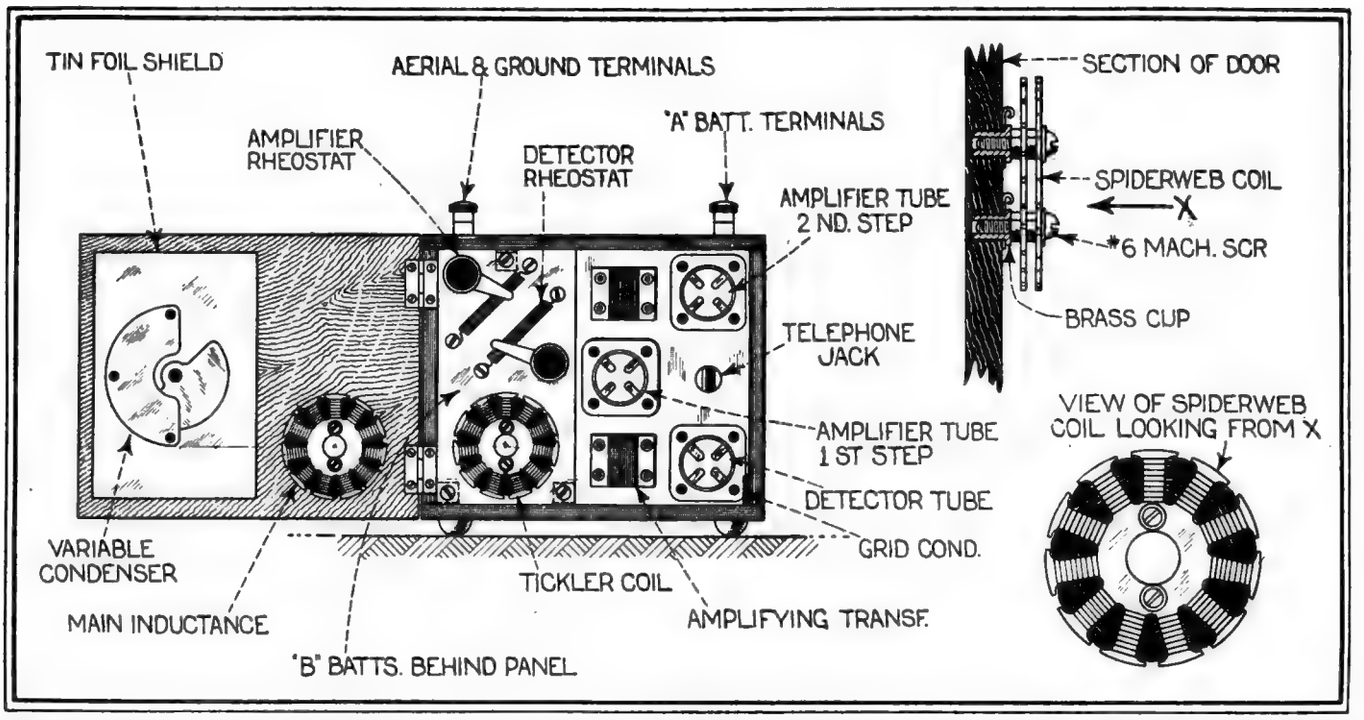


The Constructional Details of a Tuner, Detector, and Two-Stage Amplifier, Contained in a Cabinet Only 5" High by 6" Wide, by 5¾" Deep, Are Plainly Shown Above. The Spider Web Coils Are Wound on Fibre Armature Disks, as Shown in the Lower Right Hand Corner, and They Are Mounted as Shown in the Upper Right Hand Corner.

A Compact Radiophone Receiving Set

By CLYDE J. FITCH

THE illustrations show a very compact and efficient radiophone receiving set comprising a V.T., detector and two-step amplifier with all of the necessary controls, tuning, and auxiliary apparatus, including two 22½ volt "B" batteries, mounted inside of the box.

The main advantage of this set over the ordinary set is the ease in which the different stations may be tuned in. Tuning and regeneration are controlled by simply rotating the knob and dial and moving the hinged door to which one of the coils is attached in and out, all this being done with one hand. With a little practice the complete wave-length range can be covered with one motion of the hand by gradually closing the door and increasing the condenser capacity, or *vice versa*. In this way the set can be held just before the oscillation point throughout the entire wave-length range.

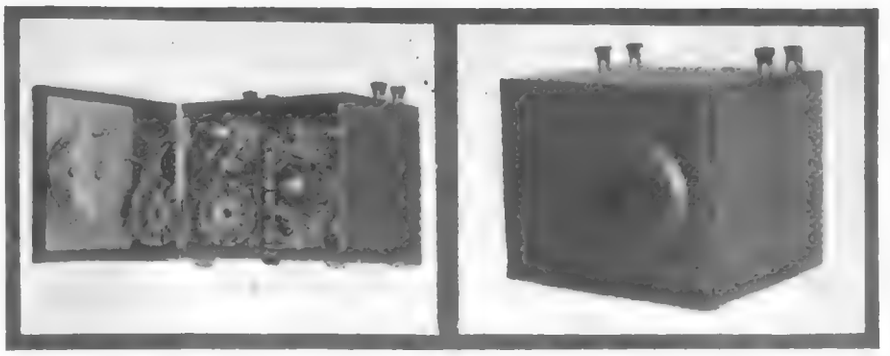
The illustrations show the general arrangement of the various parts much more clearly than words can express, so that only a few of the important features will be mentioned. There are so many different styles and types of radio parts now on the market that the builder should preferably select the necessary equipment, arrange the various parts as shown in the illustrations, and then determine the size of the box. The inside dimensions of the box containing the author's set are 5" high, 6" wide, and 5¾" deep. The wood is ⅜" oak. The little bakelite panel supporting the two rheostats and the tickler coil is 5" by 2½" by ⅛" thick, and is held in place by means of three brass screws. All wiring is of flexible cloth-covered cable, so that the panel may be swung to one side, thus allowing access to the "B" batteries, which are placed behind each panel. Each rheostat consists of a coil of resistance wire stretched between two screws, as shown; connection being made to the resistance coil by means of the small contact arm. One rheostat controls the filament current of the detector tube, and the other rheostat controls that of the two amplifier tubes in parallel.

The tuning and tickler coils are of the spiderweb type, and, although small, give excellent results. The wire is wound on the fibre insulating punchings used in motor armatures, having 11 radial notches and an outside diameter of 2¼". The tickler coil comprises 45 turns of number 28 gauge green silk covered wire. The antenna coil is constructed as illustrated, so that different sizes of coils may be plugged in. For the wave-lengths encountered by the amateur, one coil of 45 turns is used. For the broadcasting waves two of these coils connected in series are used as shown, care being taken to connect the coils, so that the winding of each coil shall be in the same direction. Three of these coils are used in series for the higher wave lengths. The 45 turn tickler coil is sufficient to regenerate over the entire wave-length range with either the single, double, or triple coil in the antenna circuit.

The variable condenser is connected in the ground lead, which facilitates wiring and allows the condenser to be placed directly on the grounded tinfoil shield. The shield is pasted on the swinging door, and prevents any trouble due to the capacity of the operator's hand.

There are four binding posts on top, two for the antenna and ground, and two for the 6 volt storage battery. The telephone plug is mounted in the back of the box, so that the loud speaker may be plugged in from behind and mounted on the wall. Rubber feet on the bottom hold the box above the table or stand upon which it sits so that the door will not rub against the table when opened.

Many experimenters have the impression that the amplifying transformers and tubes must be mounted several inches from each other in order to prevent howling, but this is not the case. The transformers may be touching each other. Howling is usually due to electrostatic feedback from the plate circuit of the last tube to the grid of the detector tube. With a wire 4 inches long connecting the grid terminal on the vacuum tube socket to the grid condenser, this set howled with the tubes lit to half brilliancy. By mounting the grid condenser directly on the vacuum tube socket, thus reducing the grid condenser lead to almost nothing, there was no tendency to howl.



Above Are Shown Photographs of an Actual Receiving Set Built by the Writer, Which Gives Exceptional Results. The Extreme Simplicity of Control Can Be Seen in the Right Hand Photograph.

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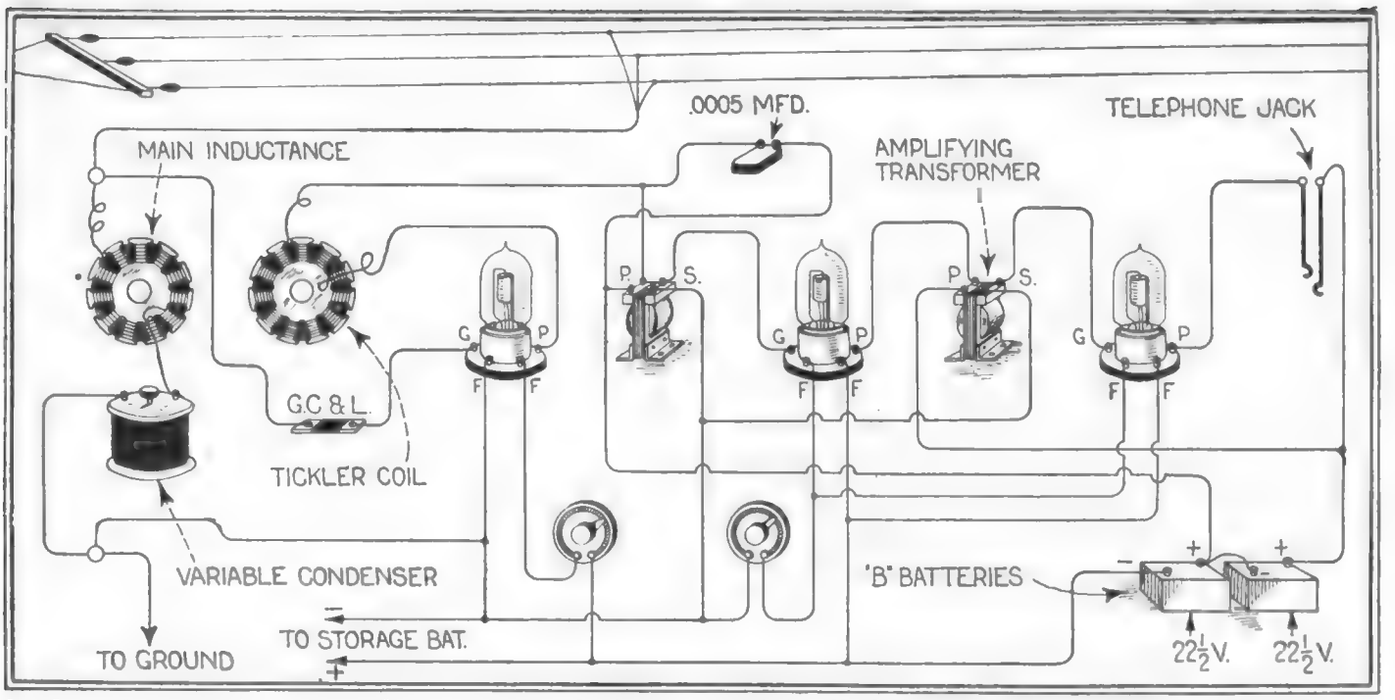

The Circuit Diagram for Connecting the Compact Radiophone Receiving Set Described by Mr. Fitch, is Given Above. This Circuit is Regenerative, and is of the Feed-Back Type. Note that the Filaments of the Amplifying Tubes Are Both Controlled With One Rheostat.

Should the experimenter find it difficult to procure the armature punchings, he can make the forms out of cardboard or fibre The simplest way to cut them is to mount several pieces of the cardboard between two pieces of thin wood. A fret saw or even a fine-toothed cross-cut saw may be used to cut out the wire retaining shapes. They may be filed or drilled also.

Radio Music by Buzzer

How would the radio amateur like to broadcast musical concerts to his friends all around the block? He certainly would, but he says the installation of a radio telephonic sending station costs a lot of money.

Here is, however, a cheap way to realize such a dream. Of course, I do not say that you will be able to broadcast music from your piano or phonograph or transmit the human voice, but you can transmit any musical melody in a very pleasant and audible way.

When you hear the stations in your receiving set you don't hear them all alike. In many instances, you can recognize them by the particular pitch of their sound. Every one of them produces a different note. Did you ever think of combining the notes from different stations so as to produce a melody? I thought it possible, so began my experiments.

My transmitting station was composed of seven buzzers and seven telegraph keys. I found that by changing the adjustment of the vibrator I could get quite a number of notes out of one single buzzer, on a principle analogous to that involved in changing the force with which a string is stretched, the latter causing different notes to be produced. The pitch of the note depends upon the number of vibrations given by the string in a certain length of time. A very similar law seems to govern the electric spark; its pitch rises and falls with its frequency. For this work you must use some special brand of buzzers which have thumb-screw regulators, as shown in Fig. 2.

The arrangement of the apparatus and the hook-up I used are shown in the accompanying diagram. The thumb-screws of the seven vibrators were so adjusted that each buzzer produced a different note. These were: C, D, E, F, G, A, B. (See diagram.) For very low notes it may be necessary to use a heavier armature or vibrator in order to get the proper pitch and for higher notes thinner armatures with stiffer springs may have to be employed.

Each one of the seven buzzers was connected in series with a corresponding key, making a piano keyboard outfit. As shown in the diagram, one of the "secondary" terminals of each buzzer is connected directly to the ground, while the other, before going to the antenna, is taken to the keyboard and is switched on and off, by means of the extension at the seat of the keys. (See Fig. 2, which shows the key in detail.)

The instrument just described opens a large field to the experimenters. There is no reason why the regular radiotelegraph stations could not use this principle, and send music around the world at a cost similar to that of the code messages, by having a number of spark gaps and motors running at different speeds or different numbers of electrodes in the rotory gaps. A four-unit outfit tuned up to the notes: B flat, E flat, F natural and G natural, is all that is needed to produce the historic Cambridge Chimes reprodced in New York by the clock of the Metropolitan Tower.

Of course the ideal method of constructing this musical device would be to connect two complete sets of buzzers to a piano keyboard arrangement, in which the piano keys themselves would act as the switches. All the sharps should be inserted, a buzzer for each half-tone would then be connected between the full notes. By means of this apparatus, the amateur can transmit regular dot-dash signals in the usual way, and should another amateur operate on the same wave-length, interference can be reduced by changing the pitch of the buzzer; in other words, by continuing the message on a differently tuned buzzer.

Contributed by A. Gonzalez Vidal.

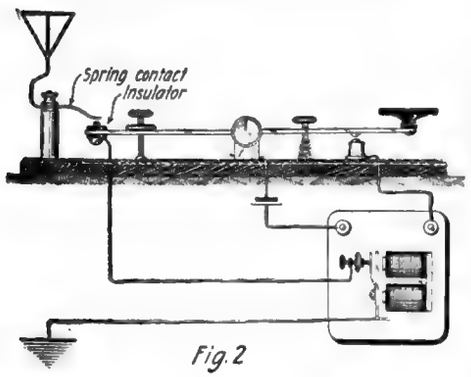

Fig. 2

At the Left, is a Side View of the Key Used For Transmitting Music by Means of a Buzzer. Note That the Antenna Circuit is Closed at the Same Time That the Battery Circuit is Completed.

At the Right We Find a Complete Lay-out of the Buzzer Music Transmitter. The Buzzers Are Attuned to the Notes on a Piano and Follow These in Sequence. One Battery Suffices For All of the Buzzers.

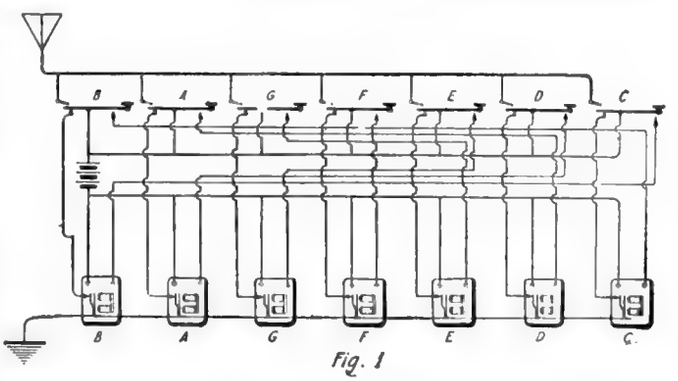

Fig. 1

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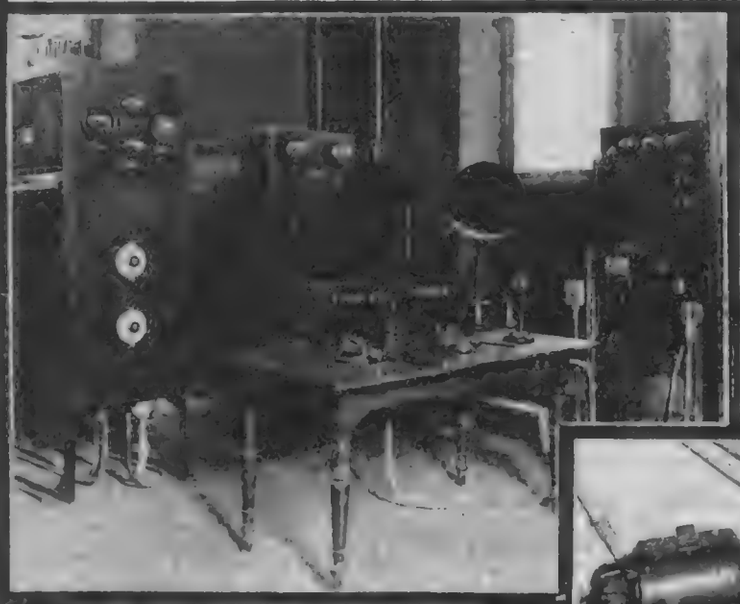
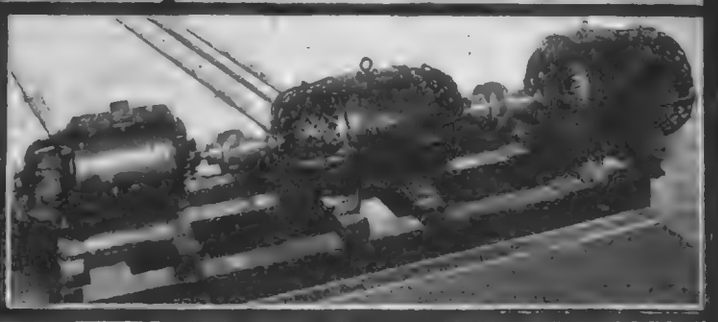
BROADCAST STATIONS





The Photograph Above Shows the Western Electric Broadcasting Installation in Station KGW of The Oregonian, Portland, Oregon. The Studio of This Station is Shown in the Upper Right-Hand Corner, and the Motor-Driven Set at Right.

The Beautiful Studio of Station WFO, of Rike-Kumler Co., Dayton, Ohio, is Shown Above. Every Precaution is Taken to Insure the Perfect Transmission of Music from This Station, Such as the Reduction of Echoes by means of Padded Walls and Floors.

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RADIO BROADCAST

THERE are so many broadcasting stations which have forwarded information, that we regret we have only space enough to print a very few. Those stations which have been courteous enough to submit photographs, will find that the photos will be published in due time. The stations listed on this sheet will not be published in the next issue. We would suggest to our readers that the map locations indicated on this page are for the special supplement map given free with the May issue of SCIENCE AND INVENTION. At a great expense this list of the stations has been practically completed as far as commercial broadcasting stations are concerned. We will present our readers with additional information on the new stations as it is brought to our attention. Address all communications to Editor Radio Broadcast, c/o SCIENCE AND INVENTION MAGAZINE, New York City.

ELABORATED LIST GIVING TIME AND NATURE OF BROADCAST (Continu ed)

Call Letters	Name	City	State	Wave Length
KDYL	Telegram Publishing Co. Lectures, music, sermons, baseball scores, news bulletins and special features daily 7.00-8.00 P. M. Mountain time. Consistient range 300 miles, maximum 2,000.	Salt Lake City,	Utah.	360-485
KDYW	Smith Hughes Machinery Co. Weather, lectures, market and stock reports, vocal and instrumental talent, and sermons daily except Sunday 4.00-5.00 P. M. Tuesdays, Thursdays and Saturdays 8.00-10.00 P. M. Sundays 7.30-8.30 P. M. Consistent range 200 miles, maximum 450.	Phoenix,	Ariz.	360
KDYX	Honolulu Star Bulletin Weather, lectures, market and stock reports, vocal and instrumental talent, sermons and special features daily except Sundays 12.15-1.15 and 6.30-7.30 P. M. Sundys 11.00-12.00 A. M. nd 5.00-6.00 P. M. Pacific time. Consistent range 200 miles, maximum 2300.	Honolulu,	T. H.	360
KDZQ	Motor Generator Co. Lectures, market and stock reports, music, baseball scores, news bulletins and special features daily 6.45-7.15 P. M. Tuesdays and Thursdays 9.00-10.00 P. M. Consistent range 500 miles.	Denver,	Colo.	360
KDZR	Bellingham Publishing Co. Weather, time signals, lectures, market and stock reports, vocal and instrumental talent, sermons, baseball scores, news bulletins and special features daily 7.15-8.45 P. M. Pacific time. Consistent range 200 miles, maximum 1800.	Bellingham,	Wash.	360
KFAU	High School Weather, lectures, market and stock reports, vocal and instrumental talent, sermons, baseball scores, news bulletins and special features, daily except Sunday 9.30-10.00 A. M., 2.30-3.00 P. M., and 8.15-9.00 P. M. Sundays 8.30-9.30 P. M. Consistent range 100 miles, maximum 500. Mountain time.	Boise,	Idaho	360-485
KFAW	Radio-Den Lectures, market and stock reports, music, baseball scores, news bulletins and special features daily except Sunday 4.00-4.30 P. M. Mondays and Thursdays 8.00-9.00 P. M. Consistent range 200 miles. Pacific time.	Santa Ana,	Cal.	360
KFAY	Virgin Radio Service Lectures, market and stock reports, music, sermons, baseball scores, news bulletins and special features Mondays, and Fridays 9.00-10.00 P. M. Wednesdays 9.00-12.00 P. M. Sunday 8.00-9.00 P. M. Pacific time. Consistent range 50 miles, maximum, heard in St. Michael, Alaska.	Medford,	Ore.	360-485
KFBC	W. K. Azbill Lectures daily except Sundays. Sermons Sundays.	San Diego,	Cal.	360
KFBE	Cline's Electric Shop Music daily except Sunday 4.00-5.00 P. M. Tuesday and Friday 7.00-8.00 P. M. Consistent range 50 miles. Pacific time.	San Luis, Obispo,	Cal.	360
KFBK	Kimball-Upson Co. Weather, lectures, market and stock reports, vocal and instrumental talent, sermons, baseball scores, news bulletins and special features daily except Sunday 3.00-4.00 P. M. and 6.00-6.30 P. M. Thursdays 8.00-9.00 P. M. Pacific time. Consistent range 1000 miles, maximum 2500.	Sacramento,	Cal.	360-485
KFCF	Frank A. Moore. Lectures, vocal and instrumental talent Mondays, Wednesdays and Fridays 7.00-8.00 P. M. Pacific time. Consistent range 900 miles, maximum 2300.	Wall Walla,	Wash.	360
KFDC	Radio Supply Co. Lectures, music, vocal and instrumental talent, and special features Mondays, Wednesdays, Fridays 6.00-7.00 P. M. Saturdays 8.00-10.00 P. M. Sundays 4.00-5.00 P. M. Pacific time. Consistent range 25 miles, maximum 1700.	Spokane,	Wash.	360
KFFA	Dr. R. O. Shelton Vocal and instrumental talent daily 6.00-7.00 P. M. Pacific time. Consistent range 100 miles, maximum 3000 miles.	San Diego,	Cal.	360
KFGH	Stanford University Lectures and special features daily. Pacific time. Consistent range 100 miles, maximum 500.	Stanford Univ.,	Cal.	360
KFV	Foster-Bradbury Radio Store Weather, lectures, market and stock reports, music, sermons, news bulletins and special features on Mondays, Wednesdays, and Fridays, from 8:00 to 9:00 P. M. Mondays, Tuesdays, Wednesdays, Thursdays, Fridays and Saturdays from 3:00 to 3:30 P. M. Consistent range 500 miles, maximum 800.	Yakima,	Wash.	360
WAAW	Omaha Grain Exchange Weather, lectures, market and stock reports, music, sermons, daily except Sunday, 8:45, 9:45, 10:45, 11:45 A. M. and 12:30, 1:30 and 8:00 P. M. Central Time. Consistent range 500 miles, maximum 1000 miles.	Omaha,	Nebr.	360–485
WAAY	The Yahrling-Rayner Music Co. Lectures, music, baseball scores, news bulletins and special features daily except Sunday 5:30 P. M. Tuesdays, Thursdays, and Saturdays, 7:30 to 9:00 P. M. Consistent range 100 miles, maximum 300 miles.	Youngstown,	Ohio.	360
WCAO	The Sanders and Stayman Co. Lectures, music, and special features daily except Sundays 12:00 noon and 5:00 P. M. Mondays and Wednesdays 7:30 P. M. Eastern Standard Time.	Baltimore,	Md.	360
WCAR	Alamo Radio Electric Co. Lectures, music, sermons, Mondays, Tuesdays, Wednesdays, Thursdays, and Saturdays, 8:30 to 9:30 P. M. Fridays 9:30 to 10:00 P. M. Sundays 2:30 to 3:30 P. M. Consistent range 300 miles, maximum 1500.	San Antonio,	Tex.	360
WDAK	The Hartford Courant Weather, lectures, market and stock reports, music, sermons, and special features 2:30, 3:30, 4:30, and 5:30 daily except Sundays. Mondays, Wednesdays, Saturdays and Sundays 8:15. Sundays 4:30 P. M. Eastern Standard Time. Consistent range 100 miles, maximum 700.	Hartford,	Conn.	360
WHAW	Pierce Electric Co. Weather, music, and special features daily except Sundays. 12:00 to 1:00 P. M., 4:00 to 5:00 P. M., and 8:00 to 10:00 P. M. Consistent range 50 miles, maximum 100.	Tampa,	Fla.	360

(To be continued in the next issue—save these as they will not be repeated.)

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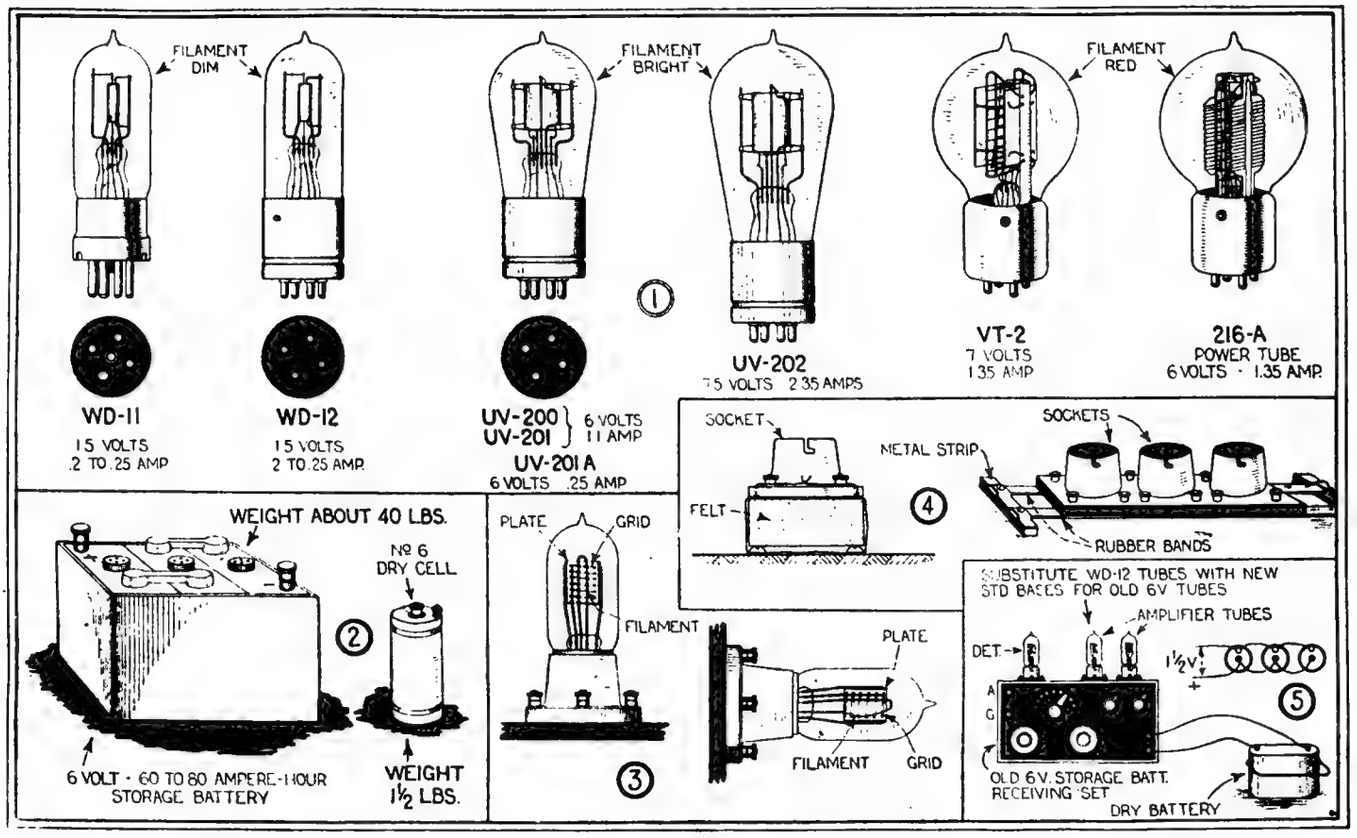
Radio For The Beginner

By ARMSTRONG PERRY

No. 15--Selecting An Electron Tube

THE beginner who makes up his mind to learn all about electron tubes should begin by taking a college preparatory course. The next step is to secure a college diploma, which can be done in four years by a student who is willing to spare some time from baseball, football and the other major activities of the modern institution of learning. Then, a good electrical engineering course can be covered in four years more and by that time he will be fairly well prepared to begin his study of the "mystery bottle," that enables one-half of the world to listen in on the other half. In order words, the electron tube is a complicated device, but it is not necessary to know all about electron tubes in order to select one that will give satisfaction.



To the Beginner Who Desires to Build a Vacuum Tube Receiving Set, the Diagram Above Illustrates Some of the More Common Types of Vacuum Tubes, Giving the Current Consumption of Each and the Types of Bases Found Upon Them. It Also Illustrates Various Methods for Mounting the Sockets. Fig. 2 Shows Difference in Weight of Storage Battery and Dry Cell. Fig. 3 Shows How Filament Sags When Bulb is Mounted Horizontally. Fig. 5 Shows Receiving Set Refitted with WD-12 1½-Volt Audions in Place of 6-Volt Type, and Use of Multiple Dry Cell Battery Instead of Storage Battery.

Formerly electron tubes were called "vacuum tubes." The new name was suggested because absolute vacuum is harder to get than an income tax receipt, and also because in radio work it is not always desired. A tube with some gas in it may work better than one from which approximately every molecule of gas has been removed. But this "approximation leaves millions of molecules in the bulb. The name "electron tube" came from the Electron, which some years ago took its place as a fraction of the Atom, and as perhaps the smallest midget in the circus of the universe. Placed side by side with an atom, an electron would look smaller than Tom Thumb gazing up at Jumbo, if both could be magnified so as to be visible at all, or than one of the bricks of the Woolworth Building when compared with the whole gigantic structure. A company of the not mere millions, about the same as the number of dollars it would take to pay our war debt, or the number of German marks, or Russian rubles, it takes to equal in value a piece of real gold money. They try to tell us that the electron may yet be dissected and divided. For radio purposes it is sufficient to merely recognize its existence. Electrons are constituents of the atoms out of which men are made, also animals, trees, plants and everything else that we see, taste, smell, touch or hear.

Every electron carries a charge of negative electricity. Some scientists alter the statement by saying that the electron is a charge of negative electricity. Whatever it is or carries, is of no more importance to the radio beginner than it is to know whether a steer is beef or carries beef.

The electron tube is a device for making electrons work in such a way as to enable radio beginners, and others who are interested, to think that they hear sounds that are produced at a distant radio transmitting station. Some electrons are pumped into the tube, in the form of an electric current, by what is called an "A" battery. They are put in under such pressure that they heat the filament, or small wire, inside the tube. When the filament gets hot enough to glow, it throws all the electrons it can get rid of off into the gas or vacuum in the tube. There are other pieces of metal in the tube, the grid and the plate. These are also charged with electricity, but carry less electrons usually than the filament, and the electrons thrown from the filament therefore flock to them, like ejected miners to a union relief-tent. Since it is electrons that make up a current of electricity, this passage of electrons from filament to plate and grid is a flow of current.

It was discovered several years ago that such a current, once in motion, could be acted upon by the current picked up by a radio antenna from passing radio waves, so that it would reproduce in a telephone receiver the sounds made at the radio transmitting station, giving a very good imitation of the human voice, the music of an instrument, or the buzz of a dot-and-dash transmitter. The current from the antenna is brought into the grid of the electron tube usually, and instead of getting only the sound that such a small current is capable of producing, we get the tremendous volume produced by the battery currents in the phone or loud talker and at the same time the modulations which are produced at the sending station and which make music or speech.

In selecting an electron tube the beginner, of course, is anxious to get one that will do the work efficiently, last a long time, and cost as little as possible. No tube costs less than a pair of working shoes, and it is human to complain, but the average beginner would rather pay twice the price than be obliged to even read over the calculations necessary in producing a tube, if he knew what the designer and manufacturer are up against.

In asking for a detector tube, the first

(*Continued on page 73*)

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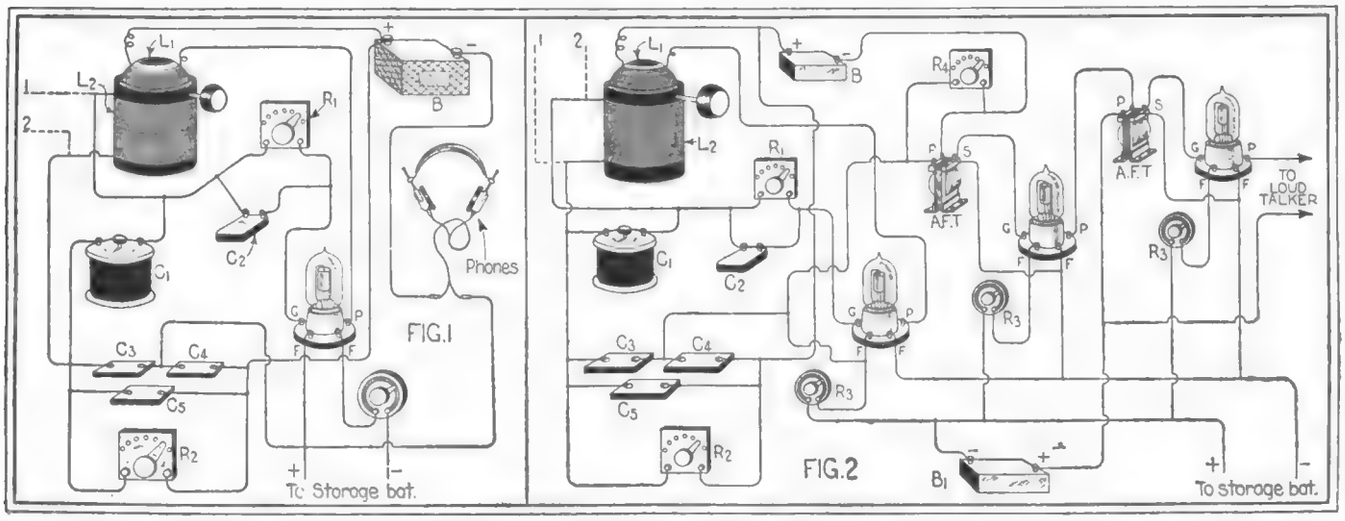
Radio Oracle

In this Department we publish questions and answers which we feel are of interest to the novice and amateur. Letters addressed to this Department cannot be answered free. A charge of 25c is made for all questions where a personal answer is desired.

THE FLEWELLING CIRCUIT

((138) George Strobel, Brooklyn, N. Y., asks:

Q. 1. Can you give me full information on the Flewelling circuit, including the latest data on the instruments used, and also give a diagram showing how to add a two-stage amplifier to this circuit?



The Flewelling Circuit Which Has Created Such a Sensation Among Amateurs is Shown Above. At the Left the Standard One-Tube Circuit is Shown, and Each Instrument Clearly Drawn so that the Novice Will Have no Trouble in Hooking Them Up. To the Right is Shown the Same Circuit with the Addition of Two Stages of Audio-Frequency Amplification. When a Loop is Used, It Should be Connected to Points Marked 1 and 2.

A. 1. The Flewelling circuit has been said by various authorities to be nothing more or less than a modification of the Armstrong super-regenerative tuner. However, whether or not this is the case will have to be decided by the United States Patent Office officials, as Mr. Flewelling has filed an application for patents covering his circuits. Mr. Edward T. Flewelling, the inventor of the circuit, is an electrical engineer, and has conducted a series of some 200 tests with his newly developed circuit, in an endeavor to improve the same, and correct faults which it originally had.

One of the greatest talking points for this circuit is that it does not require an aerial, a simple loop or only a ground connection being necessary, although in some cases with certain instruments and under certain conditions the use of an antenna, but no ground, will be found advantageous. This is a point which the amateur must determine for himself by experimentation.

Fig. 1 shows the Flewelling circuit in its simplest form. As will be seen, the only difference between this circuit and a standard single circuit regenerative tuner is the addition of three fixed condensers, and a variable resistance. The condensers C3, C4 and C5 have a fixed capacity of approximately .006 M. F., although the exact value is not critical. R2 may be a fixed resistance of ½ megohm, although in some cases it will be found to advantage to have this resistance variable from ¼ to 1 megohm. The resistance R1 is critical and must be variable from 1 to 1½ megohms. These resistances can be easily made by the amateur from the data given in the article entitled *Radio Wrinkles for Those Who Build Their Own* appearing on page 882 of the January, 1923, issue of SCIENCE AND INVENTION, Fig. 3. After these two units are made up the ohmic data should be determined on a Wheatstone bridge or on a Megger in order to be sure that the resistances are correct.

C2 should be a standard mica grid condenser with a capacity of .00025. In all cases the condensers should preferably have mica dielectric, and all the apparatus should be constructed as efficiently as possible in order to avoid losses, and also to keep the set from becoming critical.

In this circuit only one tube is used, that tube functioning as an oscillator, regenerator and detector. This tube should preferably be an amplifier, in which case the "B" battery voltage should be from 60 to 150 volts, although in some cases it will be found possible to use a detector tube applying as high a potential as possible to the plate. Any type and make of tube may be used in this circuit, including the WD-11 dry cell tube. Five-watt power tubes give excellent results.

The inductance coils L1 and L2 may be of various types. Honeycomb coils give good results, L1 being a 75 or 100 turn coil, and L2 a 50 or 75 turn coil. The correct values may be found by experiment. A vario-coupler may be used in place of the honeycomb coils, but the rotor should be re-wound so that it contains at least 75 turns of wire. A standard vario-coupler with about 50 turns on the rotor has been found to work in this circuit, but the results are not the same as would be obtained when the correct values for the coils were used. The variable condenser C1 should have a maximum capacity of .0005 M. F., and in order to secure proper results should be equipped with a vernier. Shielding of this apparatus, as well as of the filament rheostat, is quite desirable in order to reduce the capacity effect caused by the body of the operator.

The coupling of the two inductance coils will be found to be critical, loose coupling being generally employed for best results. After the circuit is once connected, and the proper values for the inductances and condensers determined, the adjustment of the same is comparatively simple. When connecting up the apparatus, it will be found necessary to try reversing the tickler coil in order to secure proper results. In most cases, when using a vario-coupler for the inductance coils, it will be found that the total inductance of the stator may be left in the circuit, and controlled by the variable condenser C1.

When everything is ready, turn on the current to the filament of the tube, place the resistance R1 at about 1½ megohms, and adjust the coupling until a shrill note is heard in the phones. Now, if the tickler is adjusted further, it will be found that the frequency of this note will change. Vary the coupling and the capacity of C1 continuously until a signal is heard. During this process of tuning, squeaks, howls and noises similar to those heard in the ordinary regenerative tuner will be produced. After the signal is heard, balance all the instruments for best results, paying particular attention to the adjustments of the two resistances R1 and R2. After these latter are obtained correctly, they may be left at these positions, and all further tuning done with the coupling and the condenser.

The amateur will find it to advantage to have a switching arrangement so that the aerial, ground or loop may be used at will, or any combination of the three. This will aid materially in experimenting with this new circuit. In all cases when only an aerial or ground is used alone, it will be found necessary to connect the same to the grid side of L2.

If the constructor is not satisfied with the volume of sound obtained, he may add audio frequency amplification to this circuit by the method shown in Fig. 2. It will be noticed in this circuit that a resistance R4 is to be connected across the primary of the first amplifying transformer. The adjustment of the amplifier depends, to a large extent, upon the correct value of this resistance. It may be constructed in the same way as R1 and R2, and should be variable from ¼ to 5 megohms. This resistance stabilizes the circuit to a very great extent, and prevents the howls and screeches which would otherwise be found present when using amplification. When this amplifier is used, it will in some cases be found necessary to readjust the grid leak, but after some experimenting it will be found that the addition of this two-stage amplifier does not impair the ease of tuning.

The amateur should never attempt to use amplification with this circuit until he has fully mastered the operation of the one tube circuit. The application of antenna, ground and loop applies to Fig. 2 in the same way as stated above in connection with Fig. 1.

This tuner is, of course, in its experimental stage, and the amateur should not be discouraged if he does not obtain the results he desires at first. Constant application to the circuit and observance of the various rules stated above will go far toward complete success.

Three Stars

Sir Oliver Lodge, of Radio fame; Dr. J. A. Fleming, B.S., A.A., one of the foremost authorities on Radio; Ellis Parker Butler, one of the greatest living humorists and author of "Pigs Is Pigs," "Philo Gubb, Correspondence School Detective," and other Funny stories, are all represented in the big May issue of

Radio News

Some of the other interesting articles appearing in the May issue are:

The Ears of the Fleet, By Charles F. Carty.

The Neutrodyne Receiver — The Latest Invention of Professor L. A. Hazeltine.

The Saturation Point. By Armstrong Perry.

Construction of an Efficient Reinartz Tuner. By Howard S. Pyle.

How to Transform a Regenerative Receiver Into a Tuned Radio Frequency Amplifier. By Charles G. Kahant.

A One-Step Reflex Amplifier. By Bert T. Bonaventure.

Notes on the WD-11 Tube.

TYPE OF ANTENNA

(139) James A. Haskins, Waterloo, Iowa, asks:

Q. 1. Will a 6-wire antenna 25 feet long placed in an attic about 28 feet above the ground on 2-foot spreaders, give good results when used with a regenerative set using a vario-coupler and two variometers in connection with a detector and one-stage of audio frequency amplification.

A. 1. You should be able to get results with the use of the antenna you mention, but we would say that they would not compare with a single wire outdoor antenna, 100 feet long.

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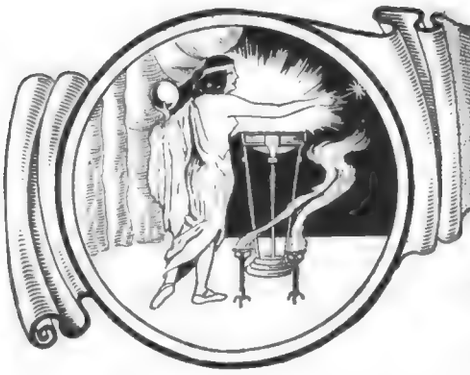


THE ORACLE

The "Oracle" is for the sole benefit of all scientific experimenters. Questions will be answered here for the benefit of all, but only matter of sufficient interest will be published. Rules under which questions will be answered:

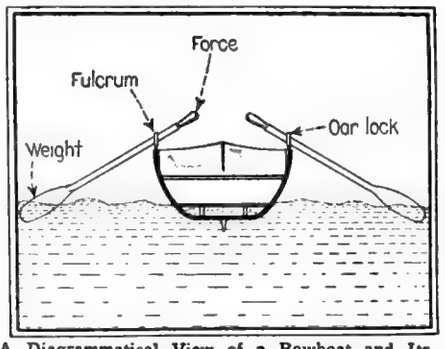
1. Only three questions can be submitted to be answered.
2. Only one side of sheet to be written on; matter must be typewritten or else written in ink, no penciled matter considered.
3. Sketches, diagrams, etc., must be on separate sheets. Questions addressed to the department cannot be answered by mail free of charge.
4. If a quick answer is desired by mail, a nominal charge of 25 cents is made for each question. If the questions entail considerable research work or intricate calculations a special rate will be charged. Correspondents will be informed as to the fee before such questions are answered.

A ROW BOAT PROBLEM

(1453) Minter Wherritt, Pleasant Hill, Mo., asks:

Q. 1. In a discussion of the levers in which weight, force and fulcrum are considered, where would you consider the fulcrum in rowing a boat, and where would the force and weight be considered?

A. 1. It depends entirely on the point of view. The modern school does not classify levers under three headings. In rowing a boat, the fulcrum of the lever could be considered to be the oar-lock, and the end of the oar in the water, the weight end, while the end on which you pull is the force end. In other words, you have a lever of the first class, in which the arms of the rower supply the force, and the water is the object against which the work is done. This is shown in the diagram. On the other hand, the blade of the oar could be considered to be the fulcrum—the oar-lock, the weight and the force, the handle of the oar, making it a lever of the second class.



A Diagrammatical View of a Rowboat and Its Oars Are Shown Above. This Illustrates the Lever Action Which is Explained in the Text.

STOMACH JUICES

(1454) Fred Wilson, Ellenville, N. Y., asks:

Q. 1. Is it possible to make a mixture that will have the same effect on food as that due to the juices found in the stomach?

A. 1. It is quite possible to make a compound which will have the same general effect upon food as the juice in the stomach. You must remember, however, that part of the stomach juice is directly derived from the salivary glands, being taken into the stomach after the masticating process.

Simply add a small quantity of pepsin to a .04 per cent solution of hydrochloric acid in water. This solution will act upon albumens and proteins in the same manner as the stomach juices. You will find that if you drop pieces of the white of a boiled egg, or any other form of albumen, into a test tube of this solution, that it will be digested in much the same manner as in the stomach.

ENAMELING LEATHER

(1455) Max Wassman, San Francisco, Cal., asks:

Q. 1. How can special color enamels be made?

A. 1. The manufacture of true enamel is a quite complicated process, and generally a heat of 1200 to 1500 degrees F. is required to melt it. If you wish to make up some special colors yourself, we would suggest that you use a good earth pigment mixed with a first quality spar varnish, or else write to the various enamel companies for information on their products.

Q. 2. How can these enamels be applied to leather?

A. 2. Such enamels cannot be applied to leather. Enameled leather is practically varnished and painted. It is necessary to treat it first, so as to close the pores in order to present a suitable surface for receiving the enamel. This may be done as follows: Boil together 14 parts of raw linseed oil, one part of dry white lead, and one part of silver litharge, until the compound is thick enough to dry in 15 or 20 minutes when [illegible] plate into a thick elastic mass. [illegible] chalk or yellow ocher to the [illegible] while it is boiling.

The leather is stretched and this compound spread on one side of it. The leather, still stretched on the frame, is placed in a drying closet, and dried by steam heat at 80° to 160° F., the heat being raised gradually. After removing from the drying closet, the coat previously laid on is smoothed off with fine pumice, and then the leather is given two or three coats of special enamel varnish. Be sure that each coat of enamel is dry before applying the next, and rub each one down with fine pumice, with the exception of the last coat.

MALLEABLE GLASS

(1456) Irene Worrell, Media, Pa., asks:

Q. 1. Just what properties are necessary for malleable glass and has such a glass ever been perfected?

A. 1. Malleable glass should present sufficient elasticity so that when struck with a hammer, instead of shattering and splintering, it will merely bend. Its elasticity does not have to be as great as a rubber band, of course, but it should be sufficient to prevent slight concussions from fracturing the same.

The triplex glass now found upon the market approximates only to malleable glass; a piece only ⅜ inch thick will not produce detached splinters, even when struck by a high caliber bullet fired from an army revolver. This glass, although shattering, does not permit any of the fragments to fly about.

IMPORTANT
TO NEWSSTAND READERS

IN order to eliminate all waste and unsold copies it has become necessary to supply newsstand dealers only with the actual number of copies for which they have orders. This makes it advisable to place an order with your newsdealer, asking him to reserve a copy for you every month. Otherwise he will not be able to supply your copy. For your convenience, we are appending herewith a blank which we ask you to be good enough to fill in and hand to your newsdealer. He will then be in a position to supply copies to you regularly every month. If you are interested in receiving your copy every month, do not fail to sign this blank. It costs you nothing to do so.

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AUTOMOBILE QUESTIONS

(1457) William W. Wallis, Washington, D. C., refers to an article appearing in the "Motor Hints" Department of this magazine, wherein it was stated that the ignition of an automobile should not be turned off while descending grades "on compression" as the muffler is liable to be blown to pieces, owing to the unburnt charges in the muffler being fired when the ignition is again turned on. He states that he has always used this method of slowing down his car on steep grades, and has always turned off the ignition without encountering trouble when the same is turned on. He asks:

Q. 1. How is it possible for an explosion to occur in the muffler when the engine is turning over at the same speed as the car is traveling?

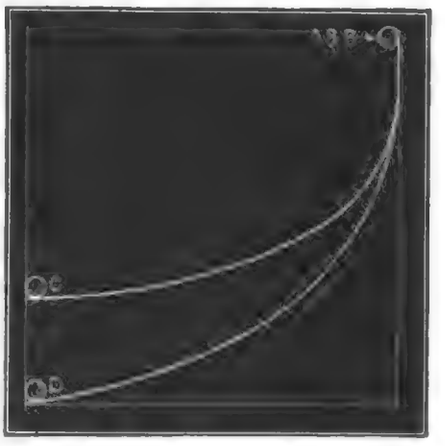
A. 1. Actual experience and the advice of automobile engineers, prove it is possible for a muffler to be exploded by cutting off the iginition current while descending hills, owing to the unburnt mixture in the muffler being fired by hot particles from the exhaust of the engine when the ignition current is turned on again.

We have known of cases where this has happened, and the only reason why it has not happened in your case at some time or other, would seem to be mostly good luck.

You say that the car and engine are still turning at the same speed, etc., but this has nothing to do with the gas charges being sucked in through the engine valves, and pumped out again into the exhaust system without being burned or exploded, and if you are descending a hill using the compression of the engine to hold the car, which means of course, that the engine has got to turn over at a fair speed, the engine is certainly sucking in a goodly charge of gas mixture. Of course, if you disengage the clutch long enough so that the engine is inactive for a sufficient time to allow the unexploded gas charges in the muffler system to pass out to the atmosphere, it is quite possible that by using careful judgment you can operate the car as you state, but, from the editor's experience, it would seem that not everyone would be able to do this in just the right way every time.

SPEED OF FALLING OBJECTS

(1458) Fred Palmer, Kansas City, Mo., sends a diagram which is reproduced in these columns, and asks:



In the Problem Illustrated Above, Ball A Will Reach Point C Before Ball B Reaches Point D.

Q. 1. If two weights, A and B are dropped from the point indicated, and follow the two paths ending at C and D respectively, will the two weights reach the latter points at the same time, or if not, can you tell me why?

A. 1. Referring to the accompanying diagram, we would say that if balls A and B are dropped from points of the same height designated by the letters A and B, along the paths terminating at C and D respectively, the ball A will reach the point C first, due to the fact that this drop in vertical distance is shorter than that of the ball B terminating at the point D.

DESTRUCTIVENESS OF VIBRATIONS

(1459) L. W. Staunton, Indianapolis, Ind., asks:

Q. 1. Did you ever publish any information on the destructive qualities of vibrations?

A. 1. The subject of the destructiveness of vibrations has been discussed time and again in the pages of this magazine. One very good article on this work entitled THE ODDITIES OF SOUND appeared in the May, 1920, issue, and a fiction story called THE VIBRATOR OF DEATH appeared in the January, 1922, issue. In the former article it was shown how a large building such as the Woolworth Bldg. could theoretically be wrecked by playing certain notes on a bass-viol.

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MULTIPLEX TELEPHONY

(1460) Ralph M. Wade, Niles, Ohio, asks:

Q. 1. Will you describe the system of sending a number of telephone conversations over the same circuit without interference?

A. 1. At various times in past issues of SCIENCE AND INVENTION there have appeared articles dealing with the methods of transmitting several telephonic communications over the same line simultaneously by means of audion tubes. We would advise you to look up some of these articles, but would say that the principle of the apparatus is as follows: The audion tubes are so arranged and connected as to supply a carrier wave of a certain frequency to various transformers. Each transformer is connected to a source of a different frequency, the output of the transformers being connected to the line. The voice is now super-imposed upon the carrier wave assigned to the particular transmitter into which the voice is spoken, and carried along the line to the receiver, which receiver is arranged so as to respond to only one certain frequency. The carrier waves usually start at a frequency of about 40,000, and go up at intervals of about 5,000 cycles. Very satisfactory results have been obtained with this method of telephonic transmission, six conversations being carried on simultaneously between New York and Boston over one line.

RISE AND FALL OF TIDES

(1461) W. E. Wilmarth, Medina, N. Y., asks:

Q. 1. Can you give me any information as to the rise and fall of tides through the United States?

We give you herewith the information requested.

Average Rise and Fall of Tides

Places	Feet	Inches
Baltimore, Md.	1	2
Boston, Mass.	9	7
Charleston, S. C.	5	2
Colon, Panama	0	11
Eastport, Me.	18	2
Galveston, Tex.	1	0
Key West, Fla.	1	2
Mobile, Ala.	1	6
New London, Conn.	2	6
New Orleans, La.	none	none
Newport, R. I.	3	6
New York, N. Y.	4	5
Old Point Comfort, Va.	2	6
Balboa, Panama	2	6
Philadelphia, Pa.	5	4
Portland, Me.	8	11
San Diego, Cal.	3	11
Sandy Hook, N. J.	4	8
San Francisco, Cal.	3	11
Savannah, Ga.	6	6
Seattle, Wash	11	4
Tampa, Fla.	2	2
Washington, D. C.	2	11

RECEIVERS FOR DICTAGRAPH

(1462) C. A. G., St. Louis, Mo., says he has a dictagraph manufactured by a certain company, and asks:

Q. 1. Can I increase the sensitiveness of this apparatus by employing 1000, 2000 or 3000 ohm phones, and which of the three would be best?

A. 1. You cannot use either 1000, 2000 or 3000 ohm phones on the dictagraph, for the simple reason that these phones are of high resistance, and very little current will flow through the winding, the transmitter itself, not functioning properly in the circuit. A low resistance phone, 4 ohms or less, is desirable.

SPARK COILS AND A. C.

(1463) Ralph Thornburg, Martinsburg, Iowa, asks:

Q. 1. If an alternating current is run through a spark coil provided with a vibrator, what kind of a current is produced in the secondary coil?

A. 1. An alternating current, if run through a spark coil, provided with a vibrator, will produce in the secondary another alternating current, broken up by the make-and-break of the coil, which make-and-break, however, will be of a higher frequency than that of the A. C. In other words, one alternating current will be superimposed upon another alternating current in the secondary, and in some places you will get an abnormally high peak, and in another place a very low drop.

Q. 2. If an alternating current is run through a coil not provided with a vibrator, what kind of current is produced in the secondary?

A. 2. If an alternating current is run through a non-vibrating coil, an alternating current with the same frequency is set up in the secondary.

Q. 3. How is the secondary voltage determined?

A. 3. In both cases the potential of the secondary circuit will be in direct relation to the number of turns of wire in the two coils, that is, if the primary has 100 turns, and the secondary 200 turns, a potential of 220 volts will be induced in the secondary, if 110 volts is applied to the primary, disregarding losses.

THALOFIDE CELLS

(1464) O. C. Thal, Kitchener, Ont., Canada, asks:

Q. 1. Can you tell me how to make a Thalofide cell, or refer me to some place where I can obtain this information?

A. 1. The sensitive material, gallium sulphide, which goes into the manufacture of Thalofide cells must be made up fresh and used immediately, as it deteriorates rapidly upon exposure to the air. This deterioration, however, is prevented in the manufactured cells by placing them in a glass tube from which the air is exhausted.

If you wish to get further information on this subject we would suggest that you write to the Patent Office at Washington, D. C., enclosing 10 cents in coin, and requesting a copy of patent No. 1,316,350.

POROUS WIRE FOR HIGH FREQUENCY WORK

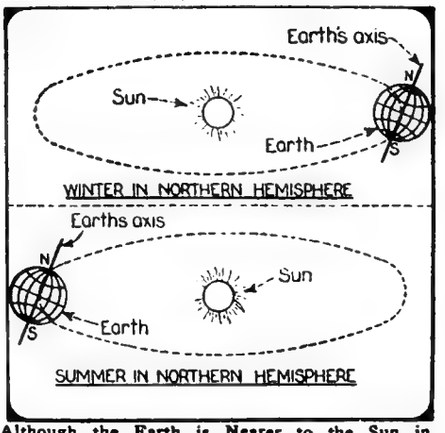
(1465) Frank C. Taylor, Chester, Pa., asks:

Q. 1. If the theory is correct which states that electricity travels over the surface of a conductor, then would not a copper wire made porous by any method, so that the area of the copper surface will be increased, allow greater amperage to flow over a given wire of certain gauge?

A. 1. Your theory of using porous copper wire is nothing new. In extremely high frequency work copper tubing and not solid copper wire, is often used, as this cuts down the expense considerably, thereby allowing the use of a larger conducter for a given cost. Making wire porous would decrease the strength so greatly that the wire would be practically non-usable.

Q. 2. Since the resistivity of copper wire increases with a temperature rise, and the carbon resistivity decreases with temperature rise, would not a wire composed of finely divided carbon dust, intermingled with copper, insure a constant resistance at all temperatures?

A. 2. Your suggestion of mixing copper and finely divided carbon dust to insure a constant resistance at all temperatures, might possibly work, but the resulting wire would be useless, because of its extremely low tensile strength. There are many wires on the market today, whose rise in resistance is practically nil when the temperature is increased; iron wire decreases in resistance when heated.



Although the Earth is Nearer to the Sun in Winter Than in Summer, the Reason for Colder Weather in the Northern Hemisphere in the Winter is Shown Above, and is Explained in the Text.

RELATIONSHIP OF EARTH AND SUN

(1466) Donato Santoro, Waterbury, Conn., asks:

Q. 1. Is the sun nearer to the earth in winter or in summer, and if the former, why is it colder at that time?

A. 1. The earth is nearer to the sun in winter than in summer, but the northern hemisphere is tipped away from the sun so that the rays reach it at an oblique angle and have to traverse a correspondingly wider belt of atmosphere. For this reason the northern hemisphere is colder when nearer the sun than when further away. In the latter position the earth is so tilted that the sun's rays are received nearer verticality in the northern hemisphere, thereby producing a warmer climate. This is illustrated in the diagram herewith.

FIGURING COST OF ELECTRICITY

(1467) Kenneth Tyler, Carrol County, Ill., asks:

Q. 1. Knowing the cost per K.W. hour, how can the cost of the operation of certain electric lamps and electrical appliances be figured?

A. 1. If you know the number of watts of power consumed by a certain piece of electrical apparatus, divide this number by 1000 and multiply by the cost per K.W. hour. The result will be the cost per hour of operating the apparatus.

If you only know the amperage consumed, multiply this number by the voltage, divide by 1000, and multiply by the cost per K.W. hour.

RANGE OF HIGH POWERED RIFLE

(1468) Frank Stutz, Pittsburgh, Pa., asks:

Q. 1. What is the farthest known distance that a steel-jacketed bullet fired from a rifle has traversed?

A. 1. Official figures place the maximum range of a steel-jacketed bullet fired from a rifle, at ten miles. It is possible that these bullets will travel even greater distances, and they will kill at a distance of three miles.

Q. 2. How far above the earth does the atmosphere extend, and at what distance from the earth does gravity cease?

A. 2. The earth's atmosphere extends above the earth to a distance of about 600 miles, it being practically devoid of any pressure at 100 miles. The distance at which gravity ceases has not been definitely determined. That it extends beyond the moon is a fact, as the gravity of the earth holds the moon in its orbit, how far beyond cannot be determined with any degree of certainty.

GLASS CEMENT

(1469) Clyde L. Smith, Fremont, Ohio, asks:

Q. 1. Can you give me the formula for a cement that will fasten together glass and metal and be able to withstand the heat of an electric arc?

A. 1. It is practically impossible to make a cement which will join glass with metal, and at the same time will stand the heat of the electric arc. It would also be unnecessary because the glass itself would melt at the heat of the electric arc.

MOTOR TO DRIVE GENERATOR

(1470) William Staurakis, Lorain, Ohio, asks:

Q. 1. How many horse power will be needed to drive a D. C. generator at 1800 R.P.M., and deliver 220 volts at 2.5 amperes?

A. 1. Allowing for slight overload, the motor required to operate a D. C. generator capable of delivering 2.5 amperes at 220 volts and rotated at the speed of 1800 revolutions per minute would be about 1 H.P.

MOVING PICTURE FILM CEMENT

(1471) Arthur W. Straule, Chicora, Pa., asks:

Q. 1. Can you give me a formula for a cement for joining together the ends of a broken motion picture film, and also tell me how to use the same?

A. 1. To make film cement, dissolve in 1 pint of amyl acetate 4 frames of old moving picture film from which the emulsion has been removed. The film should be cut up into very small fragments before attempting to dissolve it. To use this, trim the film square, and scrape the emulsion from the ends for a distance of about ½ inch. Apply the cement and clamp in the cementing press. The cement dries very quickly, so great haste must be used in doing this. Leave in the block for a few seconds and remove, whereupon it will be found that the film is firmly cemented together.

WILL OXYGEN EXPLODE?

(1472) A. J. Stephens, Fanwood, N. J., asks:

Q. 1. Will oxygen explode when exposed to an electric spark or a flame under cover?

A. 1. Oxygen will not explode when exposed to a flame or spark when under cover. It merely supports combustion and cannot be ignited.

Q. 2. What will happen if oxygen is used in place of gasoline vapor in an automobile engine?

A. 3. Nothing. The engine will be motionless.

DENTAL CREAM

(1473) W. C. Sansom, Okolona, Miss., asks:

Q. 1. Can you give me one or more formulas for the preparation of dental cream?

A. 1. We are giving you the formulas you request below.

1. Potassium chlorate, 20 drachms; powdered white soap, 10 drachms; precipitated chalk, 20 drachms; peppermint oil, 15 drops; clove oil, 5 drops; glycerine, sufficient to mass. Use with a soft brush.

2. 40 drachms precipitated chalk, 11 drachms powdered soap, 11 drachms wheat starch, ¼ drachm carmine, 30 drops oil of peppermint, 30 drops oil of geranium, 60 drops eucalyptus oil, 2 drops oil of cloves, 12 drops oil of anise mixed together and incorporated to a paste, with a mixture of equal parts of glycerine and spirit.

PASTE FOR STORAGE BATTERY PLATES

(1474) W. Stamer, San Francisco, Cal., asks:

Q. 1. Can you give me the approximate proportions for the materials used in the paste for both the negative and positive storage battery plates?

A. 1. In making the paste for the negative plates of a storage battery, mix six parts of litharge and one part of acid, and add a small quantity of barium sulphate, no exact quantity being specified. The acid used in this is diluted to the degree of one part of acid to five parts of water.

In the positive plates, five parts of red lead are mixed with one part of acid, diluted as above, and a small quantity of ammonium sulphate added

PHOTOSTATS

(1475) A. Rogers, Brooklyn, N. Y., asks:

Q. 1. Can you explain the photostat method of reproducing sections of printed matter for magazines, etc.?

A. 1. In making photostats ordinary photographic processes are employed. Instead of using plates, bromide paper is placed in the holder and the printed copy is photographed in the usual manner, a small stop opening and a relatively long exposure being required. This when developed becomes the negative, and in order to make a positive, the negative is again photographed.

USING OLD STORAGE BATTERY PLATES

(1476) J. W. Quinn, Port Arthur, Texas, says, I have a number of negative storage battery plates on hand, and would like to know if they can be used in making up storage batteries without the necessity of procuring positive plates.

A. 1. If you make up a storage battery using a number of negative plates for both positive and negative, and then charge and re-charge the battery slowly several times, you will find that the plates which are connected as positives will gradually take on that polarity.

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Money for Your Ideas

By H. GERNSBACK

(*Continued from page* 35)

and fussy. Then came the genius of the hook and eye. A man who was wide awake bent one of these hooks so as to make a hump in it. He tried hooking it up and found that it remained hooked. He patented it, and for a long time monopolized the business through his "See that hump" advertisements.

The almost perfect range-finder of today was developed under the auspices and encouragement of the Board of Ordnance and Fortifications. The manufacturer and the inventor of the instruments rushed to our forts in the early days of the Spanish war scare and made $75,000 or more from this one type of instrument. As representing the development of defense auxiliaries, the perfection of the range-finder may be taken as a good example. The first specifications required that the maximum error should not exceed one per cent per thousand yards of range. As skill in manufacture increased, the requirements became more rigid, until now the average error is less than one per cent of the range at ten thousand yards.

Another invention which brought rich returns to the originator was the soft cap used on all armor-piercing projectiles, through the medium of which the shot grips the hard face of the armor and holds fast until the energy of the projectile operates to drill it through the plate. The inventor realized over $200,000 from this comparatively simple idea.

One day a man stood behind his wife while she put up her hair. The hairpins of those days were straight pieces of wire, bent once to form two prongs. They did not "stay put" very effectively. The woman in this case bent her hairpins before putting them in. Her husband saw her do it. The result was the invention of the crinkly hairpin, which is today used in carload lots by the women of the world.

Thaddeus Fairbanks was a New England farmer. In his time old-fashioned steel yards were the only accurate means of weighing the produce of the farm. Platform scales were unknown, for nobody had ever worked out a method of arranging the levers that supported the platform in such a way that an object would pull equally no matter on what part of the platform it rested. Fairbanks used to tell the story of the evolution of the arrangement of these levers. For a long time the problem was upon his mind. He used to lie awake nights and attempt to arrange those levers in his brain. It was in the dead of night that his thinking finally bore fruit. The arrangement unfolded itself and the Fairbanks scale was the result. So did a farmer eventually monopolize the scale business of the world, and so did he write his name upon platform scales wherever civilized man buys and sells by weight.

It was Hyman L. Lipman who invented the rubber eraser that, throughout our generation, has been attached to the lead pencils in common use. It was in 1858 that the invention was made. In those times people talked in much smaller figures than nowadays. Lipman was, however, able to cash in his patents for some hundred thousand dollars, when dollars went much farther than they do today.

So did a man by the name of Heaton, a resident of Providence, notice that mother was occasioned a great deal of trouble because the buttons constantly came off the children's shoes. Heaton devised the little metal staple that holds on the shoe buttons of today and realized a fortune for his pains. No less clever was a man named Dennison, who pasted a little ring around the hole in a shipping tag and thus made an eye that would not pull out.

Elias Howe conceived the idea of placing a hole near the point of a needle. That was the germ of the modern sewing machine. Howe was one of the Columbuses in the development of a machine to sew seams and deserves a monument from the women he emancipated from needlework. When he asked Congress to extend the term of his patent for a short time (one extension had already been granted) he admitted that he had collected $1,185,000 in royalties, but considered himself entitled to $150,000,000.

Howe had many followers who improved the sewing machine. One of the cleverest of these, Allan B. Wilson, a journeyman cabinet maker of Pittsfield, Mass., dropped into the office of Munn & Company in 1849 and exhibited the first model of what has since become known as the four-motion feed. Afterwards he founded the firm of Wheeler & Wilson and became immensely wealthy.

In the *Scientific American* of 1849, James C. A. Gibbs saw a picture of Wilson's machine. The working of the device was clear down to the point where the needle perforated the cloth. He wondered what happened after that. Finally he decided to make the needle work. After much thinking and infinite whittling, he worked out the ingenious little revolving hook which became the important feature of the Wilcox & Gibbs machine and which made that firm wealthy.

The man who was born too early to wear, as a boy, red top boots with a brass tip across the toe, was also born too early to know the meaning of pride run rampant. "Silverthorn brass tips," they were called, and they were most serviceable in preventing holes in the toe. Silverthorn made his fortune out of them.

Harry Hardwick invented an ingrain carpet with the threads so interwoven as to prevent wrinkling, and Hardwick is now four million dollars better off for his pains.

The colored covers of magazines used to be printed in a most laborious way. For each color used the covers had to be run through the press once. Hence, if four colors were to be combined in a single picture, four printings were necessary. If it were only possible to print four colors at once, what a saving there would be and what a chance to sell a new kind of printing press! A Providence inventor saw the possibilities. He invented a process which is carried out in the Cottrell rotary multicolor press and which renders it possible to print three and four colors at one operation. Sixteen of these presses, costing about $30,000 each, were ordered by one large magazine publishing firm alone.

The old-fashioned carpet sweeper would seem to be capable of but little improvement. But it occurred to one manufacturer that ball bearings would make it run more easily. He carried out the idea. As a result many housewives were perfectly willing to discard their old seemingly perfect machines for the more easily running device.

Who would have thought that the old-fashioned safety razor could be improved upon? Who would have thought that the old type of blade would be eventually discarded and all honing and stropping abolished. Gillette saw the possibilities. He devised his well known handle and blade-holder and engaged a man named Nickerson to devise machinery which would turn out the blades and the handles cheaply. Millions of Gillette blades are used all over the world. Yet Gillette has had a dozen or more competitors, most of them successful, all of which shows that no one man can exhaust the possibilities that lie in a single field.

Charles Edward McCarthy was a blind man who lived in South Caroilna. He devised the method of attaching mule power to a cotton gin and lived his life out in luxury and ease while the mules did the work.

The cast iron tombstone is a patented article that is today covering the graves of many of the dead and departed. It is effective and economical. It has amassed a fortune for its inventor and proved a solace to the sorrowing though undecided survivors of the nation's dead.

R. R. Catlin, of Washington, invented a patent cat that need but be stuffed with hay and sewed up to become a toy. Such figures as "Teddy Bears" and "Billikens" and such games as "Pigs in Clover" are always worth a fortune to the inventor if they become popular. The rubber return ball made much money both for the inventor and likewise for an infringing manufacturer.

The brass paper fastener which is still generally used for thick documents was patented in 1867 by a government clerk, G. W. McGill. Yet it was not brand new, for the Romans used a similar device two thousand years ago and the modern appliance was but an improvement.

The man who invented tin cans made it necessary for somebody to invent an opener. This was done and the money corralled. A can opener is not a very laborious thing in the using, but the public is always ready to pay for things that are made easier. So, a few years ago, an inventor genius made a can with a seam just below the top and when the owner wants it opened, he has but to strike it a blow. The seam breaks and the top is off. A single Chicago packer ordered ten millions of these cans as a first order, and others followed suit.

LITTLE IMPROVEMENTS THAT MEAN BIG RETURNS

It is the history of many inventions, especially inventions which bring into popular service some new revolutionary thing that, though many minds have been working along the same line for years, almost suddenly one little thing is done that makes the invention practical and every day workable.

It may be the location of the eye in the sharp end instead of in the blunt end of the needle which made the sewing machine practical. Or it may be the backing out of a screw for a half a turn which made the telephone a success, though other inventors had exactly the same apparatus and lacked only the half turn

(*Continued on page* 80)

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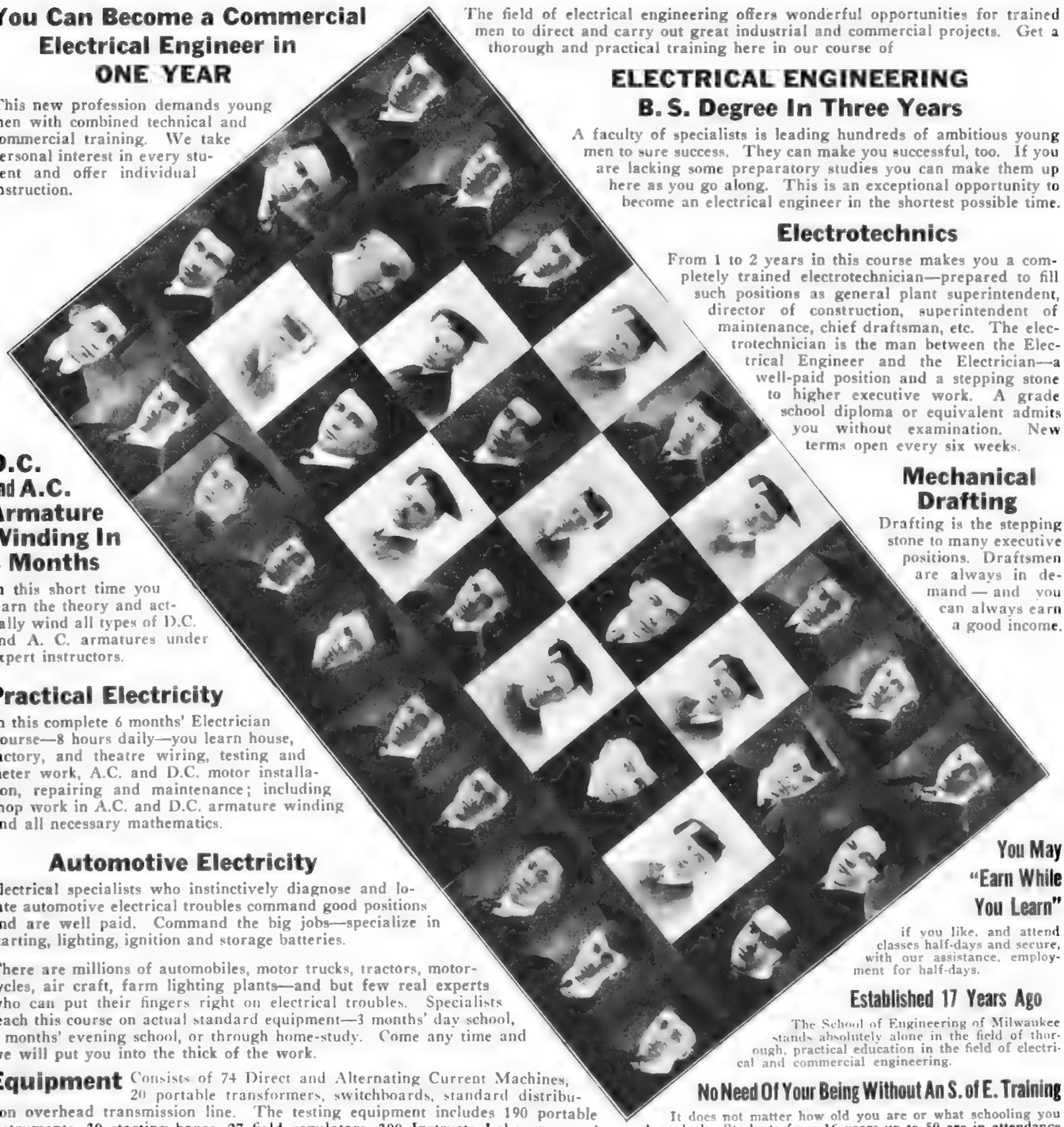

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Answers to Scientific Problems and Puzzles

By ERNEST K. CHAPIN

(*Continued from Page 38*)

THE FLOATING CORK

All objects immersed in air are buoyed up by a force equal to the weight of the air which they displace. The portion of the cork above the surface of the water is subjected to this buoyant force, which is greater, obviously, for compressed air than for air at atmospheric pressure. For this reason the cork will float slightly higher after the compressed air has been admitted than it did before.

THE CLIMBING MONKEY

As long as the monkey clings to the rope he must apply a force equal at least to his own weight, which is balanced, of course, by the equal weight of the counterpoise. In an attempt to climb, the monkey applies a somewhat greater force in order to overcome the inertia of his own body. This he is able to do because of the inertia of the opposing weight. Since whatever force he applies in an effort to raise himself is likewise applied to the counterpoise, it is evident that both monkey and balancing weight will rise at the same rate provided the inertia of the rope is negligible.

In case the inertia of the rope must be considered the monkey will rise faster than the counterpoise, for the latter will be retarded by the inertia of the rope to which it is attached.

Now, if the monkey drops for a distance and then catches hold again, the same kind of argument can be applied. If the inertia of the rope is negligible, both counterpoise and monkey will drop at the same rate and possess the same kinetic energy the instant the monkey recovers his hold on the rope. This means that equilibrium will result and the system will soon come to rest after perhaps a few momentary oscillations. But if the inertia of the rope must be considered it is clear that an unbalanced condition will result, for the monkey will drop farther and faster than the counterpoise, the former being unimpeded by the inertia of the rope. And since the kinetic energy of a moving body is proportional to its mass and to the square of its velocity, it is also apparent that the monkey will develop a greater kinetic energy than the counterpoise in the same time. Hence the energy of the falling monkey will not only stop the movement of the weight, but it will reverse its motion and raise it to the top of the pulley system.

HANGING A HAMMOCK

The only time when each of the ropes of a hammock is strained with tension equal to half the total load is when the ropes are parallel and perpendicular to the direction of the pull like those of a swing. When the hammock is laid out approximately flat, the ropes are at an angle to the perpendicular and a much greater tension will be produced, for in that case only a small part of the tension is effective in supporting the load, the rest merely tending to stretch the rope. Thus it would require a tension of not less than 2,800 pounds to support a hundred pound boy in a hammock hung with the ropes inclined within a degree of horizontal, while an infinite force would be necessary to stretch it out perfectly flat.

PASSING A WIRE THROUGH A CAKE OF ICE

To pass a fine wire through a cake of ice all that is necessary is to loop the wire over the cake of ice and suspend a weight from the lower ends. If the wire is fine the pressure (force per unit area) on the ice immediately below the wire may be enormous. This pressure lowers the melting point of the ice subjected to it, thereby making it melt. As the wire passes on through the ice in this way the water refreezes again above the wire, leaving the cake as solid as ever after the wire has gone completely through.

WANTED: 1000 VOLTS D. C.

When a high direct potential is needed for a short interval, as is the case when charging an electroscope, a convenient method is to connect several condensers in series and charge each one of them in turn with whatever potential is available. The potential of the series of condensers is then equal to the product of the potential applied into the number of condensers so charged. Thus if a man charges five condensers in turn with a battery of eight 22½-volt block batteries joined in series, the potential of the combination will be 5x8x22½, or 1,012.5 volts. Of course, no great amount of energy could be drawn from these condensers without recharging, but the method is often used for such purposes as that mentioned.

THE PITCH OF THE FIRE-BELL

In Fig. 3 is illustrated the way the pitch of a fire-bell would appear to vary if the observer were situated half way between the starting and stopping points of the engine carrying the bell. The position of the engine at any part of its trip is plotted along the horizontal while the corresponding pitch for each position is represented by the height of the curve at that point. When the engine is standing still the pitch of the bell is the same as the one natural to its particular frequency. This is represented by the height OA of the curve above the horizontal axis OO'. But as the engine picks up speed the pitch rises as shown by the upward slope of the curve from a to b. This is because the motion of the engine toward the observer shortens the length of the sound waves emitted and therefore increases the rate at which they reach his ear. As soon as the engine reaches a constant speed the pitch no longer appears to rise. This is shown by the flat portion of the curve from b to c. But the instant the engine passes the observer the length of the waves emitted is increased and the pitch appears to fall below what we have called the natural value. No further change then takes place until the engine slows down for its destination, whereupon the pitch again rises (d-e) and reaches its characteristic value the instant the engine stops.

Another curious fact which we cannot well explain without going into the mathematical treatment of the problem is that the increase of pitch due to the approach of the engine is slightly greater than the fall in pitch due to its recession. An attempt is made to indicate this on the curve, although the effect is somewhat exaggerated.

No doubt many readers know of some very interesting and unusual scientific puzzles and problems, and the author of this series of articles, Mr. Ernest K. Chapin, will be only too glad to hear from them with a description and sketch of any such problems or puzzles which they may happen to know of. We realize that one man cannot know all of the best problems and puzzles—this would be humanly impossible. Any letters sent to the Editor for Mr. Chapin, will be forwarded to him direct.

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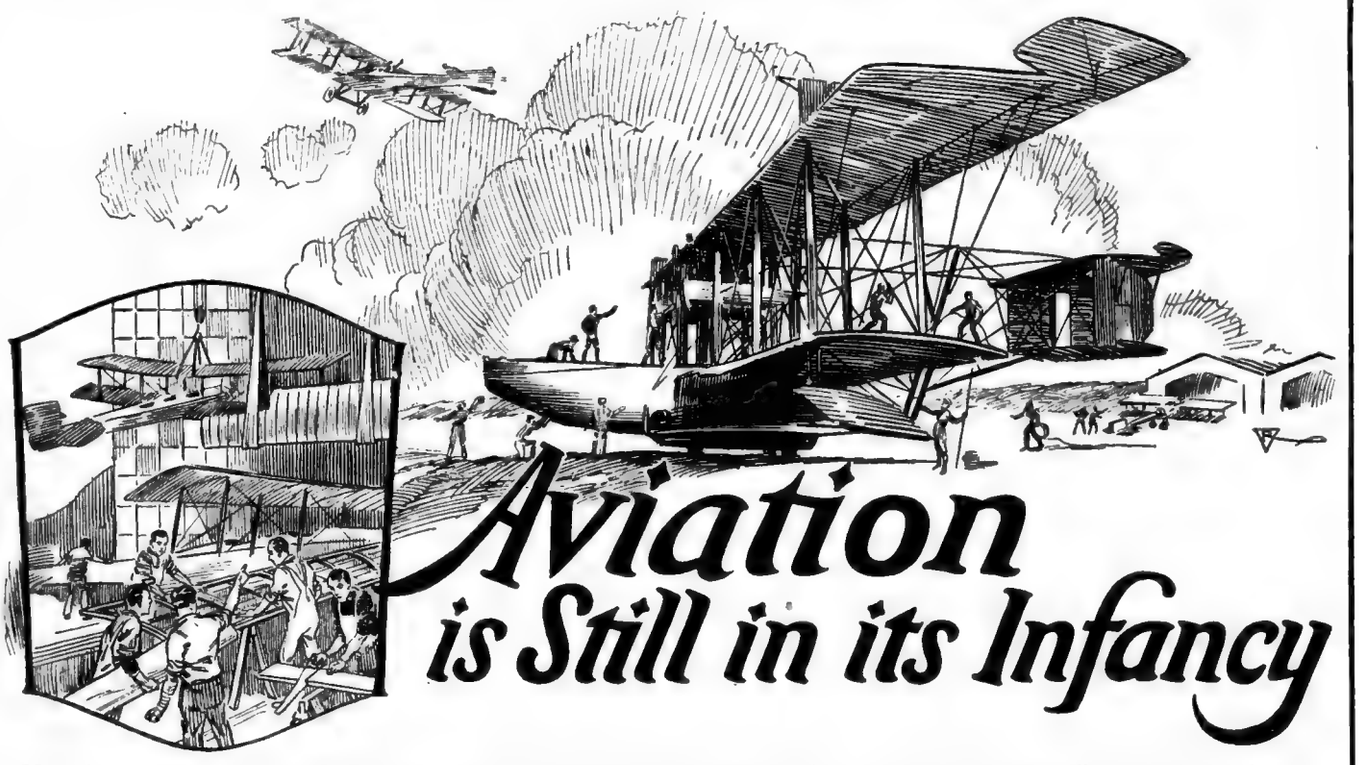

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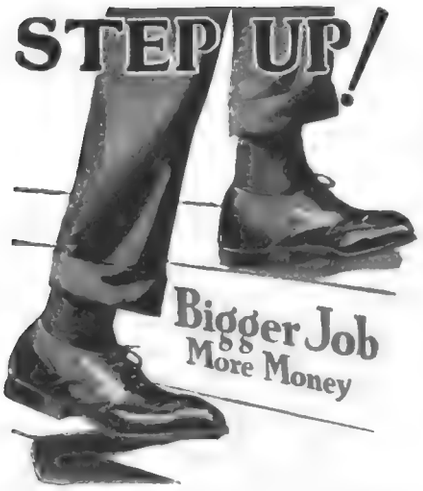

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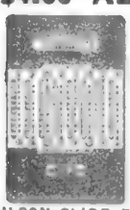

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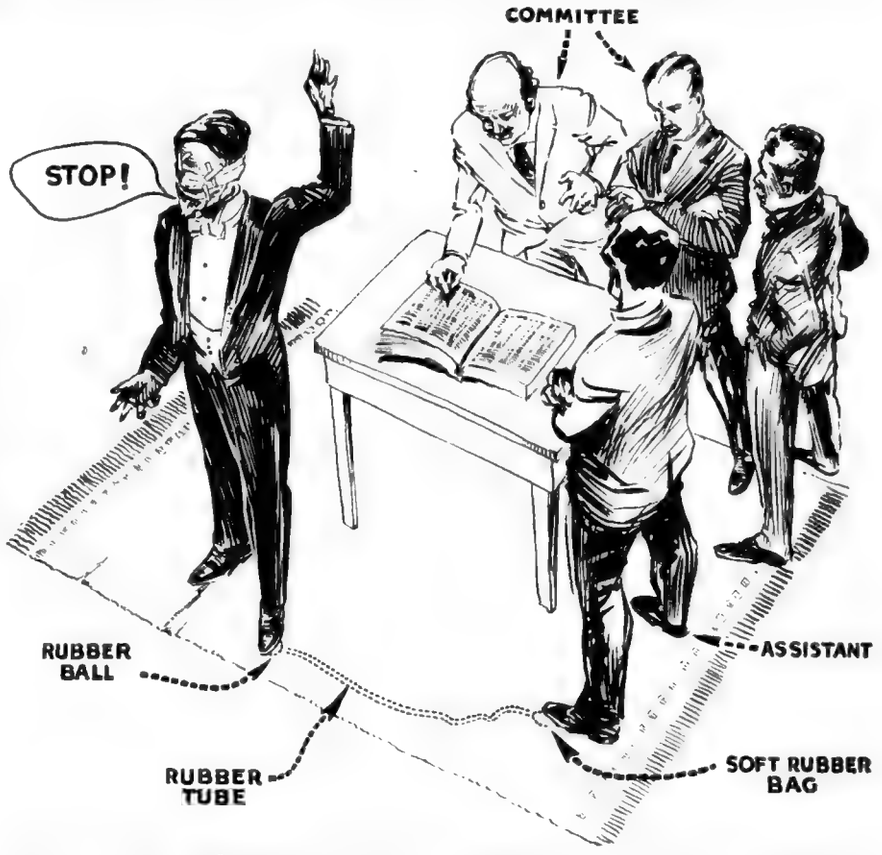
Magic for Everybody

By PROF. JOSEPH DUNNINGER

(*Continued from page 37*)

five more and he, of course, knows where to request the spectator to turn. As the spectator's finger slowly passes over the various names, the assistant awaits the moment until the finger rests upon the proper name. Another tap upon the rubber ball, and the mind

Two small doors in the front of the cabinet were opened, disclosing a large amount of wheels, mechanical devices, a few electric globes, in short, an apparently very complicated electrical mechanism. Four sets of cables led from off the apparatus to electric



In the Telephone Book Number Trick, the Magician is Blindfolded, and Led Out of the Room Where the Committee Is. One of the Committee is Then Asked to Pick Out a Certain Page in the Telephone Book and to Run His Finger Down the Column and Stop at any Name He Desires. These Facts He is Then Asked to Concentrate on, and He Then Closes the Book. The Blindfolded Magician is Brought Back Into the Room, and in a Few Moments He Tells the Gentlemen What Page Number to Turn to, and After He Has Done This He Tells Him to Run His Finger Slowly Down the Column, and He Will Tell Him When to Stop. The Method of Performing This Remarkable Trick is Explained Clearly in the Article by Professor Dunninger.

reader calls "that's the name decided upon." The miracle has been accomplished.

MESSAGES FROM THE GREAT BEYOND

Some years ago while traveling through the Middle West, I met a very interesting Hindu fakir, who specialized in what he termed East Indian spiritualism. In several weeks we became quite friendly and during the course of the conversations he explained that he was the High Priest of a spiritualistic church, and although he claimed his methods were absolutely scientific and sincere, he felt the necessity of bringing trickery into his work to strengthen the effects of his teachings upon his many followers. He further asserted that, while many of his congregation were satisfied with simple tests and manifestations, he had constructed and invented a spirit machine, which he felt would truly be the means of leaving a positive impression upon the most skeptic. I was his guest one evening, and there beheld one of the cleverest mechanical devices it has ever been my good fortune to see. As will be [illegible] the diagram accompanying this [illegible] sted of a mahogany cabi[illegible] proximately 30" off the [illegible] The cabinet itself was [illegible] and supported a metal framework upon the top, to which was affixed a slide which held a large blackboard. sockets. After an explanation to his spectators, in which he said that he had devised a machine for proving that we had absolute communication with the Great Beyond, a few switches were tampered with, the lights in the interior of the cabinet were lighted, and the machine became active. The dozens of wheels therein slowly revolved and a number of sparks and flashes played here and there upon various receiving posts. The blackboard was taken from off its stand and passed about for inspection. After having been found free from deception, it was again replaced. After a brief interval, the slate was removed and thereupon was found a message written in chalk addressed to a member of the gathering. The message was erased, the blackboard replaced, another brief interval, and another spirit communication was found thereupon. In this manner some 20 or 30 messages were produced upon the slate.

As it is my intention to discourage methods of fraud, practiced by mediums, I will herewith expose the ingenious and unusual method used by the Hindu. It may be well to state that by this exposé I am not attacking the principles of spiritualism generally,

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as I believe there is much of scientific value in the study of spiritualism. But as to the spirit machine—a glance at my diagram explains all; although to all appearances the cabinet held nothing other than mechanism, it in reality concealed a trained assistant who did the writing. As the diagram discloses, the legs of the assistant were concealed in two of the legs of the cabinet, his body hidden from view by two highly polished nickel-plated brass plates, placed at an angle of 45 degrees. In front of these plates was affixed this array of mechanism, which consisted of nothing more than a high frequency apparatus, to produce a large display of spark effects, together with two electric motors which ran a series of wheels. This apparatus was naturally reflected in the highly polished plates, and gave the audience the effect of seeing clearly to the back of the cabinet, whereas in reality it was nothing more than an optical illusion. The two electric bulbs aided further in the deception, and were also reflected, giving the audience the impression that four globes were lighted. My readers will, of course, understand that all that remained to be done was for the Hindu High Priest to equip himself with information as to those departed, and to instruct his assistant in writing messages of an appropriate nature upon the blackboard. A small trap door in the top of the cabinet acted as a convenience through which the assistant's arm could easily project during the action of writing the messages.

A CLEVER PARLOR EXPERIMENT

The apparatus necessary to bring about this very interesting and mystifying effect apparently consists of nothing more than an empty ink-well and cork, a saucer containing a small quantity of alcohol, a box of matches, a few small slips of writing paper and several pencils.

The magician requests his subject to write a series of names, or numbers, upon one of the small slips of paper. The magician may, if necessary, leave the room during this procedure. The paper is now rolled into a small ball and dropped into the ink bottle. On second thought, however, the magician advises his subject to drop the paper from out of the bottle into the saucer and light the alcohol. The paper is permitted to burn to ashes. The subject is asked to concentrate and the magician mysteriously repeats the name and numbers that have been previously written, stating that he is able to do this reading through the flames of the burning paper.

Now for the explanation. A small metal finger tip, as illustrated in the diagram, is employed. This is painted black upon the inside. A small blank piece of paper is rolled into a ball and thrown into the bottle, which should be made of black non-transparent glass. This finger tip, which is naturally flesh colored upon the outer side, is placed in the mouth of the bottle flush with its top edge. You are now prepared to present the effect.

After the subject has written the names and numbers upon the paper which is rolled into a ball, and you request him to throw it into the bottle, he, in reality, throws it into the interior of the finger tip. The magician innocently thrusts his finger into the bottle, apparently forcing the paper down, but in reality he secretly carries the slip away with him unnoticed. The rest my reader will readily understand. The duplicate paper is burnt and the magician finds time to secretly remove the finger tip, and read the original paper while under cover of the table. The subject, of course, is seated at the side of the table opposite the conjurer. This performance will be found highly effective and is well worthy of the little practice necessary to bring it about impressively. In this instance, as in all similar effects, a bit of patter helps greatly.

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A Home-Made Compound Microscope

By F. G. MARSA

(*Continued from page* 39)

enough to allow free movement of rod D and the other, and larger hole to keep stationary tube Y in place. Then, and not until then, saw this cross piece C into a triangular shape of about 4" on each side, as it is difficult to drill a large hole in ordinary building lumber as close to the edge as required by the cross piece C without splitting.

Rod D is any size up to ⅜" diameter, at least 7" long and threaded with any thread not coarser than 16 to the inch for at least 2" of its length.

The tube clamp H is made of a piece 1"x6" of any light gauge iron or brass (about 1/32" is best) bent into the shape shown in Fig. 6. An angle piece G is made of the same material about 1"x2" long, bent at right angles and punched with one hole slightly larger than the diameter of the rod D, and with another hole to pass an ordinary ¼" stove bolt P, which will clamp the angle G to the tube clamp H.

Bolt the angle G to the tube clamp H by a ¼" stove bolt P, using washers and maneuvering the *square* nut X in such a way, that when the two pieces G and H are clamped together as tight as they can be, the sides of the nut X will be parallel with the sides of the vertical leg of the angle piece G, though the position is not necessarily concentric.

Saw off the bolt P so that it will be even with the nut X. Then get a *square* nut Q for the rod D and push it in place on the angle piece G so that the hole in the nut aligns with the hole in the piece G and the stove bolt nut X by overlapping the rod nut Q will prevent the latter from twisting.

Slip the tube clamp H over the sliding tube U and lock it at about the center of tube U by the clamping bolt B, which can be another ¼" stove bolt. Then take the tube U with the clamp H and angle G and lower it over the stationary tube Y in such a way that when the collar K (locked to the rod D by a set screw) is turned, the rod D will work its way into the nut Q and the tube U can be lowered or raised over the tube Y simply by turning the collar K.

Take the black paper between which the Kodak film is wound on the spool and paste inside the stationary tube Y, which, by the way, is about 1⅛" outside diameter and not over 3½" long. For the sliding tube U the writer used a piece of 1¼" tubing 2½" long, lined with a previously blackened piece of printer's press board, longer by about ½" than the tube U, the protruding sleeve of press board being wound with the proper degree of tightness over the stationary tube Y to allow free sliding movement without admitting any light. Electrician's friction tape was used to hold the sleeve in shape and securing it to the sliding tube.

The tube Y has a small hole punched about ¼" from its lower end and this hole is aligned with a wire brad driven near the apex of the triangular cross piece C. A piece of garden hose of proper diameter to fit inside the tube Y and about ½" long is pushed into the tube Y at its lower end and the wire brad driven through the cross piece C, through the wall of the tube Y into the piece of rubber, thus preventing the tube Y from working loose. The upper end of the sliding tube U is likewise plugged with a piece of rubber hose, a longer piece, about 1¼" being used, protruding about ¾" above the top of the tube U.

The casing O is taken from a Bryant socket. If the more powerful triple magnifier is to be used for an eye-piece, it is held within this eye-piece casing O by the funnel shaped neck of an old hot water bag, out of which the metal threaded shell has been removed by placing around it a thin, narrow knife blade. The key slot in the socket shell is enlarged to ½"x1" and a slot of ¼"x½" is likewise cut in the rubber funnel.

Any other lenses besides the tripod and the triple magnifier can be used as well, if the lens of shorter focus is clamped to the base C by the Spencerian clip, while the longer focus lens is plugged into the eye-piece casing O. With the arrangement shown in Fig. 10 the maximum magnification obtained was 128 diameters, the tripod lenses of 1¼" focal length being used for the eye-piece, and the triple lens microscope of combined focal length of ⅜" for the objective.

If the experienter has one of these excellent *ultralens* microscopes, Fig. 9 will suggest the way to use it to get a magnification of about 1500 diameters.

First X-Rays of Mummies

By JOSEPH H. KRAUS

(*Continued from page* 9)

years B. C., would be in a state of perfect preservation.

Trained chemists are now working in a laboratory located in the tomb of Seti II close to that of Tut-ankh-Amen, where the work of preservation is in progress.

The word *mummy* is a term applied to the body of a human being, fish, reptile, bird or other being preserved by bitumen, spices, gums, natron (sulphate, carbonate and chloride of sodium) or other substance. It is derived from the arabic word meaning bitumen.

The Egyptians held that life would return again into the same body. The reason that many of the organs in the body were removed and either wrapped with the body or placed in separate urns or even according to some authorities were sunk in the local river appears to have been part of a religious ritual.

The writer does not hold that any of the [illegible]s were disposed of, because hap[illegible]ire life depended on a com[illegible] This could obviously not occur if portions were left in the river. These internal organs were thought to be the cause of all sin and were removed, washed and prayers were said over the entrails.

After the death of a wealthy Egyptian, the members of his family smeared their faces with mud and wandered about the city. Bare to the waists and with their clothes held high they would beat themselves. After this was done, they would carry the body to the embalmers. Here they were shown the three methods of embalming.

In the first of these, the brain was removed by means of a hook made of iron, through the nostril, so as not to damage the facial appearance. Those portions not accessible with the hook were removed with drugs, (a very good idea inasmuch as the brain undergoes decomposition quicker than any other part of the body). An incision was then made in the side and all organs within grasp were removed. In some mummies,

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the heart was not removed, in others which have been examined, sharp cuts in the aorta indicated that a knife was used in its removal. The abdomen was then rinsed and washed with palm wine, (to cleanse it of sin) and filled with powdered myrrh, cassia and other perfumes, and then was sometimes sewed up again, but more often it was not sewed up at all. It was now steeped in natron for seventy days, it being against the law to steep it longer, and at the expiration of that steeping period, it was washed and wrapped in bandages of linen cloth, smeared with gums which the Egyptians used in the place of glue. The bandages used for wrapping were from three to four inches wide and from thirty inches to twelve feet long. After the relatives received the body back, it was placed in a wooden case made in the likeness of the god Osiris, and was placed in the sepulchral chamber in an upright position.

A second method of embalming, identical with the first except that a bodily incision was not made, was to fill the abdomen with oil of cedar, no incision being made, but a pump was employed for this purpose. The mummies found before the eleventh dynasty, fall to dust the moment the sarcophagi are opened. When so opened, there is a slight smell of the bitumen. Those of the eleventh dynasty are brittle to the touch, and fall to pieces easily. The bodies are carelessly wrapped and covered with a large sheet. Those of the twelfth dynasty are dark and dry, although the bandages are rather firmly fixed. From the thirteenth to the seventeenth dynasty they are black, dry and fall to pieces on touch if found in Memphis. Those located at Thebes are yellowish, having polished nails on hands and feet.

The limbs of these mummies still bend in all directions without breaking; the bandages are applied carefully and daintily.

We desire to express our thanks to Dr. Charles W. Mead of the Museum of Natural History, and Mr. Stoye of the Kny-Scheerer Company, who have assisted in making this experiment a success.

Broadcasting Complete Operas

By LLOYD JACQUET

(*Continued from page* 45)

and facing the orchestra and audience, in the orchestra pit. Two microphones are placed to the right and left of the prompter's box. These microphones are connected to a small control switch box, and by means of switches, either microphone, or all of them may be connected in circuit.

From the control box, the impulses picked up on the stage are sent through a speech amplifier, which is usually located under the stage. The output from the speech amplifier is fed into the Western Union wires, which connect directly with the station.

On top of the manufacturing building, the impulses are amplified again, because they were weakened in their underground, submarine and air trip before they reached their first stop on their lengthy journey. By means of the station voice amplifier and of the intermediate modulator tube, the original electrical impulses picked up on the stage of the opera house are magnified so that they can now be supplied to the five powerful modulator tubes, of 250 watt rating each. This energy, which is perfectly modulated, goes to the oscillator tubes. These four tubes supply 1000 watts of power directly into the radiating system. Direct communication by telephone with the announcer in the theater is useful for an exchange of information on adjustments on both ends which will result in perfect broadcasting of the subject.

If He Had Passed It Up

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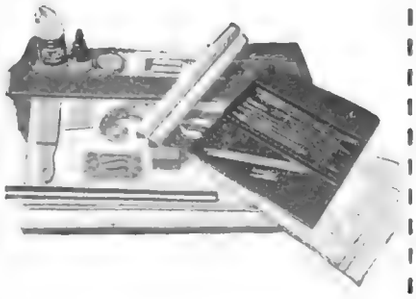

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Man's Chances Against Insects

By IVAN CALVIN WATERBURY

(*Continued from page* 14)

the rats, through their fleas, brought bubonic plague. Thereupon the Governments of Britain, Russia, France and the United States sought the advice of their entomologists, who had to undertake their work on a vast engineering scale. Even the stupendous service of exterminating the yellow-fever mosquito in Cuba and the Panama Canal Zone by General Gorgas, with all the fame it brought him, had failed to dawn on the nations as a mere vanguard skirmish in a war of extermination waged by man against multitudinous species of insects. The destruction of the handles of the tools of sappers and miners in the Crimean War by Lyctus beetles had been forgotten. The Bureau of Entomology at Washington, just after the American declaration of war, mobilized a co-operative reporting service among all the Federal and State entomologists, in the forest services and agricultural experiment stations, in the weather offices and in college faculties. The result was something like a census of insect damage and prospects.

The desert breeding-places of the grasshopper are a menace, because of the prohibitive expense of carrying insect-warfare into the inarable tracts of the Western Desert States. In the warm sand, among the sagebrush and cactus, the female grasshopper lays 1,000 eggs or more at a time. She thrusts her "telescopic" tail, or abdomen, into the soil and deposits her eggs in a sac, or "pod," formed of a glutinous substance furnished by her. This sac is sealed when full of eggs. Sometimes the eggs are laid in plant-crowns, 2,000 eggs being found in the crown of a single alfalfa plant in California. Laid in late summer or early fall, the eggs are hatched in the spring, or even in February, in Southern and Southwestern States. Except for being wingless and smaller, the young grasshoppers are like the old ones, their appetites being about equal. There is no larval or pupal stage. They are preyed on throughout their life-history by certain flies, wasps, beetles, toads, lizards, snakes, chipmunks, gophers, prairie-dogs and skunks. But not all these allies of man can prevent a plague of grasshoppers after two successive dry years.

Kansas had been overrun with grasshoppers in the years 1911-1913, when the German army was being mobilized to exterminate potato-bugs and protect crops against "*Der Tag.*" Then, as now, the American peace-time army was too small to spare a corporal's guard for such service. The Government entomological survey in the fall of 1917 discovered the imminence of another grasshopper outbreak fully as bad. This materialized the next season, but was met by extensive co-operative preparations. Thousands of pounds of white arsenic, mixed in hundreds of tons of bran, were distributed over eight counties, to the saving of 113,000 acres of wheat, worth some $3,000,000.

Though the wonderful Bureau of Entomology is alert in peace-time as in war-time, it has been greatly handicapped by small appropriations and lack of public interest, except during the war emergency. It has put forth a remarkable literature of preventive plans and measures. Its contributions toward winning the war were long to tell. Fleas infesting cattle can carry to man the deadly bacillus anthrax. Bed-bugs, in common with fleas and body-lice, bring and transmit the infantile Kala-azar of Northern Africa and Southern Europe, relapsing fever of Africa and Europe, tropical sore, and possibly leprosy, among other diseases.

An example of the difficulties of war on pestilential insects is afforded by the case of mosquitos. General Leonard Wood makes the extermination of malarial mosquitos in the Philippines a major condition of his resignation. Judging by the results of his Cuban administration, his mosquito war is likely to be more effective than the mosquito wars recently declared in New York, New Jersey, and elsewhere. Malarial mosquitos in New York are statistically shown to be more destructive to human life than thugs. Even the health and lives of gallant naval men taking care of the laid-up men-of war in the Hudson are much imperilled.

Most hopeful is the increasing scope of the Rockefeller Foundation's co-operation with various State authorities and many foreign governments against malaria and yellow-fever mosquitos, judging by its effective work in Mississippi, Louisiana, and Arkansas. Mosquitos have to be attacked in the larval stage, the eggs being hatched in water, though the mosquito does all its mischief in the adult stage. Eggs are laid in the autumn at some water's edge, or preferably on grasses or sedges of ponds. Thence, the next spring, are hatched the larvæ, known as "wrigglers." These soon become pupæ, whence the mosquito takes wing into a new element. But new broods are hatched and grown every fortnight all summer. Every cow-track and dead-furrow become mosquito breeding places after rains. So do old cans left to catch rainwater in back-yards and alleys. About the only handicap the mosquito has is that it is a poor migrant, the malaria mosquito seldom flying over a mile and the yellow-fever species seldom over half a mile. The venom is not native, but consists of a protozoan parasite called the plasmodia, which reproduces by division. Science has not ascertained where this poison organism originates, or where the mosquito acquires it, except from infected persons. The mosquito's bite is harmless until a malarial patient is bitten, all the biting being done by the female of the species. When thereafter it bites a well person the minute plasmodia ensconces itself in a red corpuscle. There it grows to full size, disc-shaped, and then divides into segments like the slices of a pie. Each segment becomes a new plasmodia and attacks a new red corpuscle. Taking quinine kills out this parasite and sterilizes the red corpuscles of fever. In no other way can malaria be cured. The object of warfare is to destroy the mosquitos' breeding-places. Drainage is effected where possible. Often a pool or marsh can be blasted with dynamite and drained underground, through the broken hard-pan. Drainage is the main dependence in sparsely settled districts.

The cost of oiling water-surfaces to kill larvæ, as the yellow-fever mosquito was conquered in Havana and the Canal Zone, tends to become prohibitive. Oiling ponds is effective only temporarily in many cases, the lakes and ponds in the vast marshes of the Gulf States, for instance, being too large and grassy. Rain breaks up the oil-cover and wind blows all the oil toward one shore. So such waters are stocked with top-feeding minnows (gambusia affinis), which devour the wrigglers as the latter swarm to the surface to breathe. But the minnows cannot reach the mosquitos hatched in the high grass near the shores. As moppers-up of these lurking-places, milch cows have been mobilized. Pastures are fenced off, reaching to the water's edge, and by keeping the grass closely cropped, the cows devastate the enemy's last stronghold. Gassing mosquito-marshes at night from air-craft, destroys mosquitos, but also bird- and plant-life.

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An Under-Sea Pleasure Trip

(*Continued from Page* 10)

front of the sled. The air hose, as stated before, entered through the nose of the sled, which received fresh air pumped from the tow boat at the surface.

As a matter of fact, the air supply could be cut off completely, there being a sufficient quantity of air in the tank to permit the passengers to ride comfortably for at least a half hour. The air hose, however, served to keep the supply of air in the sled below the surface in a satisfactory condition, so that a rapid exchange of passengers could be made through the entrance and exit without stopping too long for aeration.

Should anything happen to the air hose, that is, if it should perchance be cut, a valve automatically closes that port. The exhaust blower which blows the air out of the compartment into the water, creating a stream of bubbles in the path of the vessel, also ceases to operate when the air supply is cut off. This motor is driven by storage batteries housed beneath the floor of the Sub-sea Sled. So cleverly has this amusement been designed, and so carefully has its weight been reduced, that it is possible to float the sled at any time by simply blowing out the ballast tanks. So should an accident occur, whereby the cables towing the sled would be severed, the operator below the surface merely turns his valves, blows out the ballast tanks and rises to the surface of the sea, where he can be picked up and towed to shore. Additional safety factors are found in the form of two buoys. These hold within them a reel of hose and a reel of cable, secured to anchor bolts within the vessel. Should the Sub-sea Sled become lodged within rock crevices, or become entangled with a wreck, the operator pulls the emergency release which sends the floats to the surface. Storage battery controlled pumps now draw air into the submerged chamber from above. The wrecking crew will come along and fasten their derricks to the cables of the buoy and raise the sled without any difficulty, even before the passengers below the surface have had a chance to become excited. Oxygen tanks are further found within the sled, so that should all other agencies fail, the passengers still have recourse to a supply of oxygen, and hard tack is shipped as well as water supplied in storage tanks for extreme emergency uses. It is evident, therefore, that the designer has spared no pains in building a device which will be economical in construction and which possesses the acme of safety.

Looking through the port holes of unbreakable glass, we can see the beauties of the ocean revealed to us. There are about sixty passengers in this cigar-shaped car, some of whom are pressing their noses against the glasses, so as to obtain a better view. The searchlights above each of the portholes send out their rays of light through the relatively clear waters, leaving shafts of brilliantly illuminated sand which die out in a veil of fog-like haze as the penetrability of the light rays becomes weaker. At first we pass over a sandy bottom interspersed here and there with a few rocks. Then a vast sea-garden looms before us, ferns, sea anemes, sea weeds and other foliages are being gently swayed by the currents. We are brought alongside of the floating dock, the water-tight door is opened, and we emerge from the most interesting trip below the level of the sea which any amusement proprietor has offered, confident that we shall take the trip again before the day is done. At least we fondly hope so. The reason is that the device has as yet not been built. But we have hopes.

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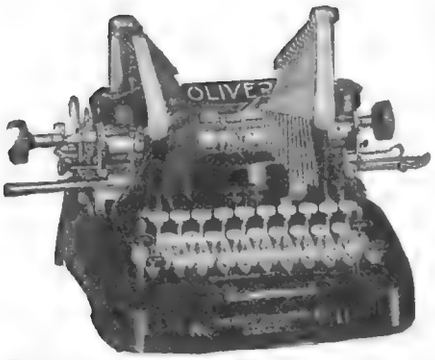

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How, When and Why Does Electricity Kill?

By M. McCABE

(*Continued from page 13*)

given voltage which might be summed up as follows:

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Time current is passing.

These factors are all more or less interdependent on one another.

The effect of the current in passing through the body is to produce muscular contraction and paralysis of the brain, as well as of the voluntary and involuntary organs. Should death not result there is likelihood of the functions of these organs being interfered with and a mental and physical deficiency or even total inability resulting. The current likewise decomposes the blood and causes an increase in the temperature of the body to as much as 128° F. or greater depending upon the current dissipated in the body. The pupils of the eyes are dilated and the optic lens is fractured.

A microscopic examination of the blood will usually prove if death is due to electrocution or other causes when there is any question as to the cause of death.

Another Step Towards Whole Truth About Evolution

By ROSWELL S. BRITON

(*Continued from page 38*)

The seemingly strange thing, however, is that the fossil does not crack also. It is the quickness of the operation that accounts for that. The heat of the flame, intense though it is, is not given time enough to penetrate through to the fossil. And the cooling drop of water does not touch the fossil at all.

The more intricate and complicated the fossil, the greater is the advantage of this method. For larger fossils, the flame-and-water treatment of course has to be repeated until the entire surface has been cleaned of rock formation.

The old method of cleaning fossils is chiseling and scraping. At best, the fossils are damaged to some extent in the course of this sort of cleaning, and too often valuable specimens are badly cracked or shattered.

Paleontologists are familiar with the disappointment of breaking priceless fossils in the last moment of cleaning them, after the fossils have been excavated and shipped from the far corners of the earth, at great expense and often with much physical hardship.

The new method of the California Academy of Science does away with the risk of breaking the fossils at this crucial stage, and makes it much easier to get the fossils in shape to be studied and reconstructed.

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This new method of cleaning fossils removes one great hazard in the long and toilsome process of gathering and cleaning such fossils for the light they can shed on matters of early natural history that still remain unknown or unproved by concrete evi-

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FINCH RADIO MFG. CO.
303 Fifth Ave. New York City

WHY NOT Special Spring, Summer and Fall gathering butterflies, insects? I buy hundreds of kinds for collections. Some worth $1 to $7 each. Simple outfit; work with my instructions, pictures, price-list. Send 10c (not stamps) for my illustrated Prospectus before sending butterflies. Mr. Sinclair, Dealer in Insects, Dept. 33, Ocean Park, Calif.

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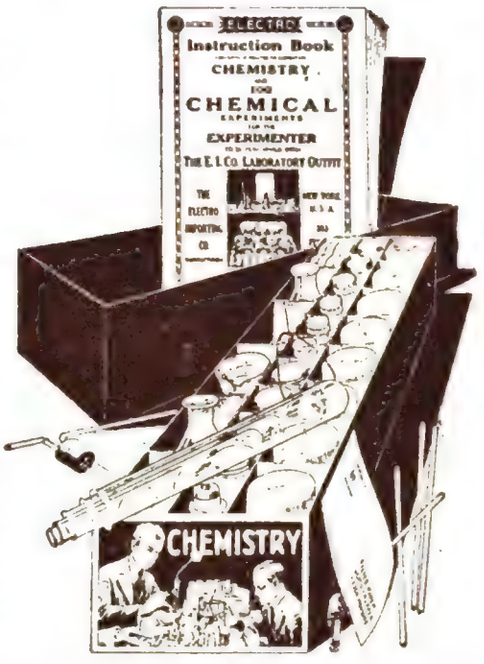
A Chemistry Laboratory for $7.00

Think of it, fellows! Here is a real chemistry outfit with regular chemical apparatus that performs those fascinating, actual chemical experiments.

This outfit is not a toy, put up merely to amuse, but a practical laboratory set, with all the chemicals, apparata and reagents necessary to perform real work and to teach the beginner all the secrets of inorganic chemistry. With this outfit we give free a book containing a Treatise in Elementary Chemistry, useful data and recipes. and 100 instructive amusing experiments.



DESCRIPTION OF THE OUTFIT

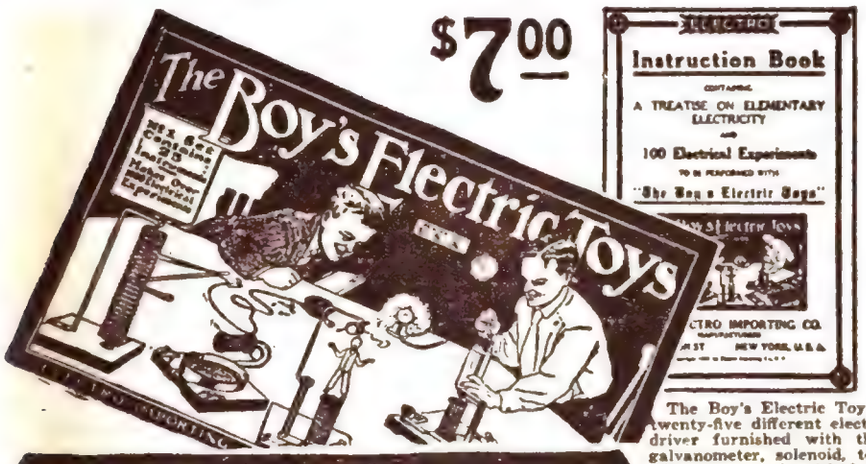
The outfit consists of forty-four (44) chemicals all C. P. (chemical pure) put up in appropriate wooden boxes, glass bottles and hermetically closed jars. The acids are put up in glass bottles, with ground-in glass stoppers, and there is a sufficient quantity of chemicals supplied (mostly one to two ounces) enough to make dozens of experiments with each.

The apparata furnished are all of the best obtainable make and of standard laboratory size and shape. 17 pieces of apparata furnished with this outfit.

The instruction book is a real Chemistry Course for the Beginner. Some of the Contents are: Division of Matter: This is a Treatise on Elementary Chemistry, and deals with the theory of the Elements, Molecules and Atoms, etc.

100 EXPERIMENTS

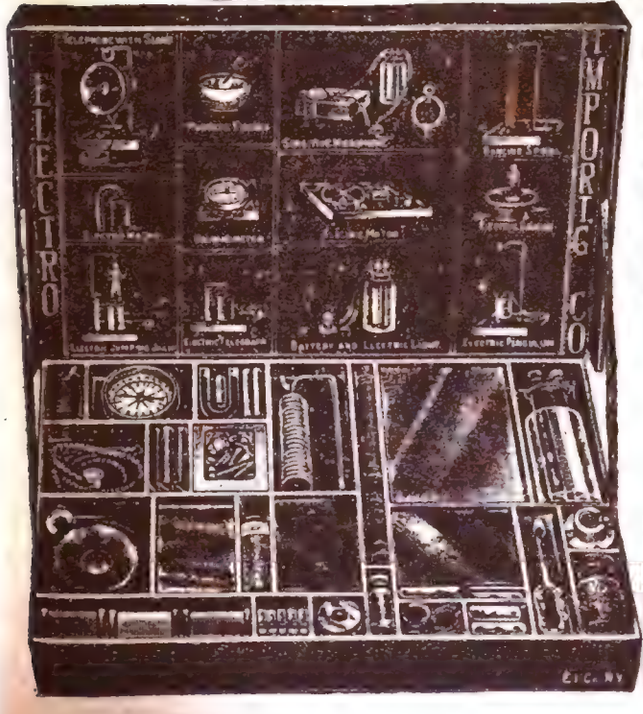
How to make chemical tricks; how to make invisible and magic inks; how to test flour; how to test soil; how to make chlorine gas and smoke (German War Gas); how to bleach cloth and flowers; how to produce oxygen and hydrogen; how to make chemical colors; how to test acids and alkalies, and hundreds of interesting hints and formulas.



$7.00

Every Fellow Wants the

BOY'S ELECTRIC TOYS



The Boy's Electric Toy contains: Enough material to make and complete over twenty-five different electrical apparatus without any other tools except a screwdriver furnished with the outfit. Student's chromic plunge battery, compass-galvanometer, solenoid, telephone receiver, electric lamp. Enough various parts, wire, etc., are furnished to make the following apparatus:

Electromagnet, electric cannon, magnetic pictures, dancing spiral, electric hammer, galvanometer, voltmeter, hook for telephone receiver, condenser, sensitive microphone, short distance wireless telephone, test storage battery, shocking coil, complete telegraph set, electric riveting machine, electric buzzer, dancing fishes, singing telephones, mysterious dancing man, electric jumping jack, magnetic geometric figures, rheostat erratic pendulum, electric butterfly, thermo electric motor, visual telegraph, etc., etc.,

This does not by any means exhaust the list, but a great many more apparatus can be built actually and effectually.

With the instruction book we furnish one hundred experiments that can be made with this outfit, nearly all of these being illustrated with superb illustrations. No other materials, goods or supplies are necessary to perform any of the one hundred experiments or to make any of the 25 apparatus. Everything can be constructed and accomplished by the means of this outfit, two hands and a screwdriver.

The outfit contains 114 separate pieces of material and 24 pieces of finished articles ready to use at once.

We guarantee satisfaction.

The size over all the outfit is 14 x 9 x 2¾. Shipping weight, 8 pounds. "The Boy's Electric Toys" outfit as described, $7.00. Immediate shipment.

SEND FOR YOUR SET TODAY

REMEMBER

JUST CLIP THE COUPON—DON'T SEND MONEY

ELECTRO IMPORTING CO., 233 Fulton St., New York City

ELECTRO IMPORTING CO.,
233 Fulton St., New York.

Please send me by express THE CHEMICAL LABORATORY. If I don't like it I need not accept it. If I want it I only pay $7.00 plus the few cents express charge.

.....

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ELECTRO IMPORTING CO.,
233 Fulton St., New York.

Please send me by express THE BOY'S ELECTRIC TOYS. If I don't like it I need not accept it. If I want it I only pay $7.00 plus the few cents express charge.

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S. & I. 5-23

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BUILD YOUR SET WITH BARAWIK STANDARD

PLATE CIRCUIT "B" BATTERIES

You can make real savings on these batteries. Don't pay more. We guarantee them to equal any on the market regardless of price. Absolutely uniform. Extra long life.

K180 Signal Corps type, small size, 15 cells 22½ volts. Each....95c

K184 Variable L. Navy size, 6½x4x3 inches 5 taps, giving range from 16½ to 22½ volts in 1½ volt steps. Each.....$1.80

K188 Combination Tapped 45 volts 30 cell, 13x4x3 battery. Tapped to give 45, 22½, 21, 19½, 18 and 16½ volts. Handles both detector and amplifier tubes. Each.....$3.55

HOMECHARGER BATTERY CHARGING RECTIFIER

Charge your battery at home over night for a few cents. Simply connect to any 110 volt 60 cycle light socket, turn on current and rectifier does the rest automatically. Will work for years without attention. Simple connections. Gives a tapering charge which batteries should have. You can make it pay a profit charging your friends' auto batteries. Long connecting cords with pair of battery clips.

Prices are Transportation Paid.

K201 For 6 volt battery $12.95
K203 For 12 volt battery 13.95

STORAGE "A" BATTERY

A very high grade battery made especially for radio service. Guaranteed for three years. Properly cared for will give many more years of service for filament lighting. Made of best new materials. Full capacity. The best battery buy on the market. Try one of these batteries on your set for 10 days. If at the end of that time you are not fully satisfied with the battery return it and we will refund the purchase price.

K194 6 volt, 40 ampere size. Each....$10.00
K196 6 volt, 80 ampere size. Each.... 12.50

BATTERY CLIPS

K198 Two for 20c
Clip onto storage battery terminals, lead coated. Make positive non-corrosive contact at all times.

WIRE CONNECTING CLIPS

K199 Per dozen 30c
Small connecting clips for quickly fastening leads onto binding posts, etc. Handy and useful. Every radioist should have at least a dozen.

PORCELAIN BASE SWITCHES

Fine white porcelain bases. Copper contacts and blades. Can be used as antenna switches.

K383 Single Pole Single Throw. Each 20c
K383 Single Pole Double Throw. Each..32c
K384 Double Pole Double Throw. Each..80c

FILAMENT CONTROL RHEOSTATS

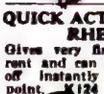
Crosley—Wound on vulcanized fiber. Adjustable to any panel. Complete with knob.
K130 Each 45c

Best grade. High heat resisting base. Diam. 2⅛ in. cap 1⅛ amp. Resist. 6 ohms. 1¼ in. knob with pointer. 75c value.
K132 Each 45c

POTENTIOMETER

Same style as above rheostat. Gives fine "B" battery adjustment. Resistance 200 or 300 ohms
K133 Each 90c

VERNIER RHEOSTAT



Gives exceedingly fine control of "A" battery current. A necessity for best receiving results.
K135 Each 75c

QUICK ACTING VERNIER RHEOSTAT

Gives very fine control of current and can be switched on or off instantly at any desired point. K124 Each $1.10

Porcelain Base Rheostat for table mounting. Resist. 10 ohms.
K136 Each 75c

WE PAY TRANSPORTATION CHARGES EAST OF THE ROCKIES

THE PRICES QUOTED DELIVER THE GOODS TO YOUR DOOR

FAST SERVICE—TRY US AND BE CONVINCED

THIS GUARANTEE PROTECTS YOU—Examine the goods we ship you. They must suit you in every respect.. If you are not satisfied with your purchase return the goods at once and we will refund the price you paid.

AGENT-DEALERS WANTED

We want Agent-Dealers in every locality to handle our line of goods.

Our Proposition Means Money to You

Our prices save you money. The quality of our goods insures satisfied customers. Our service will help you do a large business on a small investment.

SEND FOR OUR CATALOG

We have selected a line of goods—both completed sets and parts to assemble sets—that will enable you to supply every demand and make money. You can make a good income on our proposition with a very small investment.

Our catalog shows the merchandise you should handle, gives much radio information and will help you establish a successful business. Tell us what you can and want to do, and how much you can invest. We'll do the rest.

For the Person Who Makes His Own Set

Our catalog is interesting and valuable. Even if you are not interested in radio as a business you will find many interesting things in this catalog and you will save money buying your supplies from us.

VACUUM TUBES

Standard Brands—Cunningham Radiotron. Every one guaranteed new and perfect. We will ship brand in stock unless you specify otherwise.

K185 Detector, UV200 C300 Ea. $4.38
K112 Amplifier UV102 A-C301A Each $5.95
K118 5 Watt Transmitter.....$7.20
K187 WD11 1¼ v. Fil. Each.....$5.85
K188 WD11 Socket. Each..... 49c
K189 WD11 Adapter. Each..... 49c

FOUR-IN-ONE SCREW-DRIVER

K674 Each 55c
Especially suitable for radio work. Will handle any size screw used. Smaller drivers nest inside larger one and are held in place with screw cap. Made of steel, nickel finished. Every radio builder can use several of these handy tools.

VACUUM TUBE SOCKETS

Our Special Socket. A wonderful value. Moulded entirely of brown bakelite. Four binding post connections. Right angled contact springs.
K140 Each 35c

PORCELAIN BASE AND TUBE

K144 Crosley for either panel or table mounting 35c

High Grade combination type for panel or table mounting. Metal tube. High insulation base. One of the best sockets made.
K146 Each 45c

TWO AND THREE GANG SOCKETS

These sockets make it easy to build detector and amplifier units and make a neat, compact workmanlike job. Perfectly made of high grade materials. Quickly mounted on panel or base.
K147 Two-gang socket $1.05
K148 Three-gang socket 1.45

FIXED CONDENSERS

Moulded cases, nickeled binding posts.
K804 Each 45c

CARBON PRESSURE VERNIER RHEOSTAT

Current regulation is obtained by changing of pressure on carbon. This permits of infinitely fine variation of current. Very durable. Resistance 15 ohms. Capacity 2½ amperes.
K131 Each $1.65

RADIO TUBES

Tubes for winding coils. Strong solid material, with smooth clean surface.
K950 Diameter 3 inches, per foot.....20c
K951 Diameter 3½ inches, per foot 25c
K952 Diameter 4 inches, per foot 30c

MURDOCK LOUD SPEAKER

K610 Each, complete $4.75
This speaker gives excellent results and is actually superior in quality and volume of tone to many others selling at several times the price. You will be pleased with it. One of the best radio values ever offered. Black moulded base. Reproducing unit directly attached to aluminum sound chamber. Fibre amplifying horn. Five foot connecting cord with plug included.

MAGNAVOX LOUD SPEAKER

K612 Each $29.50
Model R3 genuine Magnavox.

WORKRITE LOUD SPEAKER

K614 Each $9.95

VARIABLE GRID LEAK

Pencil mark type. Resistance may be varied exactly as needed. K160 Each.....10c

GRID CONDENSER

K162 Mounting holes spaced to fit lugs of above leak. Can .00025 MF. 14c
K163 Same as 162 but higher grade. Enclosed in metal case. 30c

PHONE AND GRID CONDENSERS

A compact style of condenser that is very satisfactory. Conducting sheets and dielectric are wound on fiber strip with eyelets for mounting and connections. Each 12c

K170 Phone Condenser .001 Mfd.
K172 Phone Bridging Condenser .0005 Mfd.
K174 Grid Condenser .00025 Mfd.
K176 Grid Condenser .00025 with pencil mark leak. Each.....24c
K178 .006 Mfd. for Flewelling circuit. Ea. 25c

TUBULAR GRID LEAKS AND CONDENSERS—MOUNTED STYLE

Very convenient. Permits quick change of leaks or condensers of varying capacities.

Grid Leaks Each	Price 35c		
	Resistance		Resistance
K850	.5 Meg.	K855	2. Meg.
K851	1 Meg.	K857	3. Meg.
K853	1.5 Meg.	K859	5. Meg.

GRID AND PLATE CONDENSERS

Price, each 55c

K830	.000025 Mfd.	Correct for Myers Tubes.	
K832	.0001 Mfd.	For special circuits	
K834	.00025 Mfd.	For U.V.201 and Cun. 301	
K836	.0005 Mfd.	For U.V 200 and Cun. 300	

MOUNTINGS

Bakelite base. Spring clip contact.
K840 Single mounting. Each.....32c
K842 Double mounting. Each.....57c
K844 Trinle mounting. Each.....75c

"HONEYCOMB" COILS

Carefully made—fine looking coils. Highest efficiency. Low distributed capacity effect, low resistance—high self inductance. Very firm impregnation. Range given is in meters when varied with .001 variable condenser. Mounted coils have standard plug mountings.

Turns	Range	Art No.	Not Mntd.	Art No.	Price Mntd.
25	120- 250	K301	$0.39	K320	$0.69
35	175- 450	K302	.42	K322	.96
50	240- 720	K303	.49	K323	1.04
75	380- 910	K304	.54	K324	1.08
100	500- 1450	K305	.58	K325	1.13
150	600- 2600	K306	.63	K326	1.17
200	900- 2500	K307	.72	K327	1.26
250	1200- 3500	K308	.78	K328	1.35
300	1500- 4500	K309	.82	K329	1.39
400	2000- 5000	K310	.97	K330	1.57
500	2800- 6100	K311	1.12	K331	1.63
600	4000-10000	K312	1.27	K332	1.78
750	5000-12000	K313	1.43	K333	1.99
1000	7900-15000	K314	1.70	K334	2.28
1250	9750-19500	K315	1.92	K335	2.49
1500	14500-26500	K316	2.18	K336	2.65

COIL MOUNTINGS

K340 Three-coil mounting $3.95
K341 Two-coil mounting $2.95
High grade fine looking mountings. Polished black composition. Center receptacle stationary, two outer ones adjusted by knobs. Takes any standard mounted coil.

COIL PLUGS

Made of moulded bakelite. Fits any standard plug. Mounts any standard honeycomb coil.

K344 Each 50c

PANEL MOUNTING COIL PLUGS

Take any standard mounted coils. Made of moulded bakelite, mounted on brackets.
K345 Stationary. Each 89c
K346 Movable with anti-capacity handle Each $1.10

RADIO FREQUENCY AMPLIFYING TRANSFORMER

K995 Very special $3.95
This transformer will get the long distance stations loud and clear. Permits of easy sharp tuning. Helps cut out static and interference. Makes your set sensitive enough to use a loop aerial. Enclosed in metal case affording perfect shielding. Suitable for panel or base mounting. Because of its special design can be mounted in any V. T. socket. Works with any style of tuner. Wave ranges 150 to 550 meters. Wiring diagrams included.

OUR SPECIAL AUDIO FREQUENCY AMPLIFYING TRANSFORMERS

As high as three stages can be used without howling due to proper impedence ratio, minimum distributed capacity, low core losses and proper insulation. Mounted style has bakelite panel with binding post connections. Unmounted has core and coils assembled with two holes in core for fastening to apparatus.

K234 10 to 1 Mounted. Each $3.40
K235 10 to 1 Unmounted. Each 2.85
K236 3 to 1 Mounted. Each 3.40
K237 3 to 1 Unmounted. Each 2.85

THORDARSON AUDIO FREQUENCY AMPLIFYING TRANSFORMER

An especially high grade transformer with correct characteristics for Cunningham, Radiotron or A. P. Tubes. Wonderful results without distortion on one, two or three steps. Low distributed capacity. Fully mounted bakelite panel.

K323 3 to 1 Ratio. Ea. $3.03
K235 6 to 1 Ratio. Ea. 4.15

RADIO CORPORATION TRANSFORMERS

Audio Frequency Amplifying Transformer Especially designed for Radiotron tubes. 9 to 1 winding ratio.
K712 Each $6.40

RADIO FREQUENCY AMPLIFYING TRANSFORMERS

Range 200 to 5000 meters. For long distance reception.
K714 Each $5.95

OUR COMPETITOR AUDIO FREQUENCY AMPLIFYING TRANSFORMERS

While these are very low priced transformers, nevertheless they will give excellent results. They are carefully designed and carefully made. Quantity production and small profits make the low price possible. They will equal in results many transformers selling at much higher prices.

K238 Unmounted, with wire leads.....$2.00
K239 Mounted, with binding post connections, completely shielded...$2.75

BARAWIK SPECIAL PANEL MOUNTING VARIABLE CONDENSERS

K812 43 plate .001 Mfd. $1.73
K813 21 plate .0005 Mfd. 1.43
K814 11 plate .00025 Mfd. 1.32
K815 3 plate Vernier... 98c
These are especially high grade condensers and we guarantee them to be mechanically and electrically perfect. Fine polished end plates of heavy bakelite. Shafts ¼ inch diameter. Sturdy, heavy aluminum alloy plates perfectly spaced to insure smooth, even reliable capacity. Our low prices save you money. These condensers are of the very best make and are not to be compared with many inferior cheap condensers offered. We guarantee them to please you or your money back.

COMBINATION VERNIER VARIABLE CONDENSERS

K824 23 plate .0005 Mfd. with dial and knobs. Price....$2.80
K826 43 plate .001 Mfd. with dial and knobs. Price....$3.45
The latest improvement in condensers consists of regular variable condenser controlled by large knob and dial mounted with a three plate vernier condenser, which is controlled by separate knob mounted above knob on dial. This arrangement permits of very fine tuning. Compact convenient mounting on panel. High grade design and construction. Finely finished.

ENCLOSED VARIABLE CONDENSERS

One of the best made condensers. Rigid, accurately spaced aluminum plates. Formica ends. Engraved scale. Knob and pointer. Clear transparent case.

K806 43 plate .001 Mfd. $3.95
K808 21 plate .0005 Mfd. 3.23

KNOCKED DOWN VARIABLE CONDENSERS

You can save money by assembling your own condensers. Formica top and base. Complete with all parts not assembled. Go together easily and perfectly. Panel mounting type.

K820 41 Plate .001 Mfd. $3.95
K821 21 Plate .0005 Mfd. 3.23

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RADIO GOODS---DEPENDABLE QUALITY---LOWEST PRICES

PRESERVE THESE PAGES—ORDER FROM THEM AND SAVE MONEY
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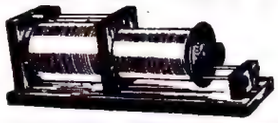
OUR GUARANTEE PROTECTS YOU—We handle only the best goods, carefully tested and checked by expert radio engineers. You are assured of getting guaranteed apparatus that will give superior results. And while our goods are best, our prices are lowest. Our goods equal or surpass the claims we make for them. We do not attempt to deceive or mislead. Our reputation for fair dealing is our most valued asset.

HOW TO ORDER—Write your Order plainly, state Article Number, Description and Price of items wanted. Send Postoffice or Express Money Order, Certified Check or Bank Draft for Total of Order. Prompt Shipment is assured when these directions are followed.



ARLINGTON RECEIVING TRANSFORMER

Will tune in all stations up to 3,500 meters. Very efficient on short waves and for radiophone reception. Used with our Detector Two Step Amplifier it produces very excellent results. Also does good work with crystal detector. Silk covered windings on formica tubes. Very fine mahogany finish wood work. Base size 6x18 inches. Slider controls primary, 12 point switch on secondary. Can be tuned very close. Brass metal parts nickel finish. A wonderful value at our price.

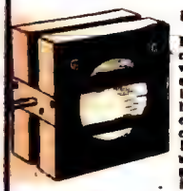
K720 Price $3.95

TUNING COIL

Range up to 950 meters. Wound with bare copper wire, machine spaced. Ends of mahogany finished hard wood. Two easy sliding contacts on polished brass rods, four binding posts. Substantial, efficient, attractive. Length, 8¾ in.

K722 Price $2.45

VARIOMETER

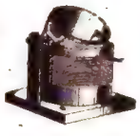


K410—Completely assembled, price $2.69

Perfect in design and construction. Accurate wood forms of genuine solid mahogany. Correct inductive ratios. Solid baked windings. Positive contacts. Highest efficiency. A real bargain.

K411—Not assembled nor wound but all parts complete except wire, including winding form. $1.48

VARIO-COUPLER



K415 Price, completely assembled $2.45

With this loose coupler and two variometers, together with the necessary other parts, a highly efficient tuning set can be made. Easily mounted on panel. No base included. Primary winding on formica tube. Inductively coupled for 180 to 600 meters. Multiple taps permit fine tuning.

K416 Not assembled nor wound but all parts complete except wire. Price $1.18
K417 Rotor ball only. Each 29c
K468 Bakelite stator tube only. Each .. 35c

MOULDED VARIOMETER

Polished black moulded rotor and stator forms. Maximum inductance with greatest efficiency and minimum distributed capacity. A high grade durable instrument that will make up into a set you will be proud of and will get the best results. Wave length 180 to 600 meters. 4¼ in. square, 1⅝ in. thick.

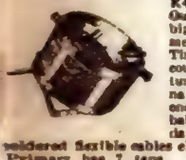
K412 Price including mounting brackets $3.95

MOULDED VARIO-COUPLER

This coupler is designed to work with the above variometer. The stator and rotor forms are of polished black moulded composition. Primary has seven taps to enable finest tuning. Wave length range 180 to 650 meters. Fitted with panel mounting bracket.

K419 Price $3.78

IMPROVED 180° VARIO-COUPLER



K418 Price $2.89

Our price shows you a big saving. An instrument of highest quality. The most efficient type of coupler, insures sharper tuning and louder signals. Primary and secondary wound on genuine bakelite tubes. Secondary connections through soldered flexible cables eliminates contact noises. Primary has 7 taps. Can be panel or table mounted. Range 180 to 650 meters.

BRASS ROD

Supplied only in 8 inch lengths.

K961 Threaded 6-32, per 8 inch length .. 8c
K963 Threaded 8-32, per 8 inch length .. 10c
K965 Solid 3-16 inch, per 8 inch length .. 10c
K967 Solid ¼ inch, per 8 inch length .. 12c

TINNED COPPER WIRE

Size 14 tinned copper wire. For wiring sets. Best size for neat job and proper results.

K960 Ten feet for 12c

CHOKE COILS AND EQUIPMENT

For Super Regenerative Circuit

K358 100 Millihenrie Iron core choke coil. Each $1.20
K354 10 Millihenrie Open core choke coil. Each 92c
K357 12,000 ohm Non-Inductive wire wound resistance. Each $1.58
K356 12,000 ohm moulded resistance. Ea. 45c
K350 5 Millihenrie Open core choke coil. Each 92c
K360 2 Henrie Iron core, choke coil. Ea. $1.20

BARAWIK QUALITY HEADSETS

These headsets have proven on rigid tests to be one of the very best on the market. The tone quality is excellent with an unusual volume. Skilled workmen make them from only the best selected materials. The receiver cases are fine polished finish with polished black ear pieces. Fabric covered head band comfortably and quickly fitted to the head. Supplied with 5-foot cord. These sets were designed to sell for much higher prices than we ask, and at our price are a wonderful bargain. We guarantee that you will be pleased with them and agree that they are the best value by far yet offered. If they don't suit you we will cheerfully return your money.

K770 2000 ohm $3.65

OTHER STANDARD BRAND HEADSETS

K751 Murdock 56, 2000 ohm $4.20
K752 Murdock 56, 3000 ohm 4.95
K764 Frost, 2000 ohm 4.20
K766 Frost, 3000 ohm 4.65
K758 Western Electric, 2200 ohm 9.50
K754 Baldwin Type C with universal jack plug $12.00
K755 Baldwin Type C unit 5.50
K756 Red-Head, 3000 ohm 5.78
K768 Brandes, 2000 ohm 6.95

TWO-WAY ROUND PLUG

K937 Each 59c

Takes two pairs of head set terminals. Quick easy connections. Polished round barrel. Fits any standard jack.

ENCLOSED DETECTOR

One of the finest crystal detectors on the market. Supersensitive galena crystal enclosed in heavy glass shield. Quick, positive adjustment. Brass parts polished nickel finish.

K730 Each $1.18

GALENA DETECTOR

Easy fine adjustment. Crystal mounted in cup. Moulded base and knob. Brass parts polished nickel finish. An unequaled value.

K732 Each 59c

DETECTOR CRYSTALS CAREFULLY TESTED

K736 Galena, Arlington tested, per piece 19c
K738 Silicon, Arlington tested, per piece 19c
K735 Tested, Galena, per piece 9c
K737 Tested, Silicon, per piece 9c

DETECTOR PARTS

K725 Price set ... 32c

All metal parts for crystal detector. No base included. Easily assembled. Polished nickel finish.

BAKELITE DIAL AND KNOB

Moulded of genuine bakelite, polished black finish. Fluted knob. Fine engraved scale with sharp clear graduations and figures in contrasting white enamel. This is the finest quality dial and knob in a very attractive pattern. Two inch cannot be supplied for ¼ inch shaft.

K915 2 in. Diam. for 3-16 in. shaft. Ea. ... 35c
K902 3 in. Diam. for 3-16 in. shaft. Ea. ... 35c
K903 3 in. Diam. for ¼ in. shaft. Ea. ... 35c
K916 4 in. Diam. for ¼ in. shaft. Ea. ... 45c

ONE-PIECE DIAL AND KNOB

Moulded in one piece of polished black composition with clean plain engraved scale and numerals in contrasting white enamel. Ribbed knob to fit the hand. An attractive neat pattern.

K900 2¼ in. Diam. for 3-16 in. shaft. Ea. 19c
K901 2¾ in. Diam. for ¼ in. shaft. Ea. ... 19c
K904 3 in. Diam. for 3-16 in. shaft. Ea. ... 25c
K905 3 in. Diam. for ¼ in. shaft. Ea. ... 25c
K906 3½ in. Diam. for 3-16 in. shaft. Ea. 35c
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ROSIN CORE SOLDER

K958 Per coil 22c

Self fluxing. Especially designed for soldering electrical connections. Fine for use with above electric iron. Coil will last a long time.

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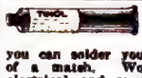
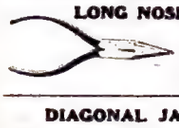


K959 Per tube 19c

With this preparation you can solder your connection with the heat of a match. Works fast. Makes a perfect electrical and mechanical joint. Self fluxing.

LONG NOSE PLIERS



K976 Price ... $1.10

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K391 Closed circuit. Each 40c
K392 Two circuit. Each 60c
K393 Single circuit filament cont. 60c
K394 Two circuit filament cont. ... 85c

K395 Plug. Large space with set screws for attaching cord. Each 40c

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Well made, durable, smooth working. Interchangeable with any standard Jacks and Plugs Solder connections. Nickel finished metal parts.

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K388 Two circuit jack. Each 35c
K389 Standard plug. Each 35c

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Brass, polished nickel finish. Washer and 6-32 in. screw extending ⅝ in.

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K372 Smaller size — barrel and knob 9-16 in. long, dozen 70c
K374 Large size with composition knob, dozen 50c
K376 Large size with hole for phone tip or wire, dozen 80c
K378 Small size with hole for phone tip or wire, dozen 85c

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Brass polished nickel finish. All have ⅝ in. long size 6-32 screws and two nuts. All prices the same.

Dozen 18c Hundred $1.05

Order by Article Number.

K360 Head, ¼ in.; Diam. ¼ in. High
K362 Head, 3-16 in.; Diam. ⅜ in. High
K363 Head, 3-16 in.; Diam. 1-16 in. High

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K365 Dozen 12c — Hundred 80c

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Moulded composition knob. Exposed metal parts polished nickel finish. Fitted with panel bushing, spring and two set nuts. A high grade switch.

K382 1¾ in. Radius
K381 1¼ in. Radius
K380 1 in. Radius
} 19c Ea.

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K285 Price including knob and dial $1.80

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K900 Price $1.58

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Fine looking cabinets solidly built. Made of genuine solid mahogany in elegant hand rubbed finish. You will be proud of your set mounted in one of these cabinets. Hinged tops. Front rabbeted to take panels. Panels not included. Prices are transportation paid.

Panel Size	Inside Dimensions High	Wide	Deep	Art. No.	Price Each
6x 7"	5⅛"	6⅛"	7"	K420	$2.48
6x10½"	5⅛"	10 "	7"	K422	2.75
6x14"	5⅛"	13½"	7"	K424	2.99
7x14"	6⅛"	13½"	7"	K423	3.00
7x18"	6⅛"	17½"	7"	K426	3.80
7x21"	6⅛"	20½"	7"	K425	4.30
9x14"	8⅛"	13½"	10"	K428	3.70
12x14"	11⅛"	13½"	10"	K430	4.40
12x21"	11⅛"	20½"	10"	K432	5.85

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Panel Size Inches	⅛" thick Art No.	Price	3-16" thick Art No.	Price	¼" thick Art No.	Price
6x7	K450	$0.50	K460	$0.75	K470	$0.90
6x10½	K451	.75	K461	1.11	K470	1.47
6x14	K452	1.05	K462	1.55	K472	2.05
7x14	K458	1.20	K468	1.80	K478	2.40
7x18	K453	1.55	K463	2.30	K473	3.10
7x21	K457	1.78	K467	2.65	K477	3.60
9x14	K454	1.60	K464	2.38	K474	3.10
12x14	K455	2.10	K465	3.15	K475	4.15
12x21	K456	3.15	K466	4.65	K476	6.20

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	A Battery	2nd Step
	B Battery	3rd Step

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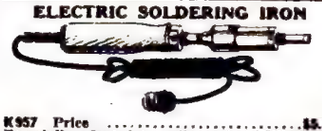

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22	75c	24	31c	24	1.05
24	85c	26	25c	26	1.18
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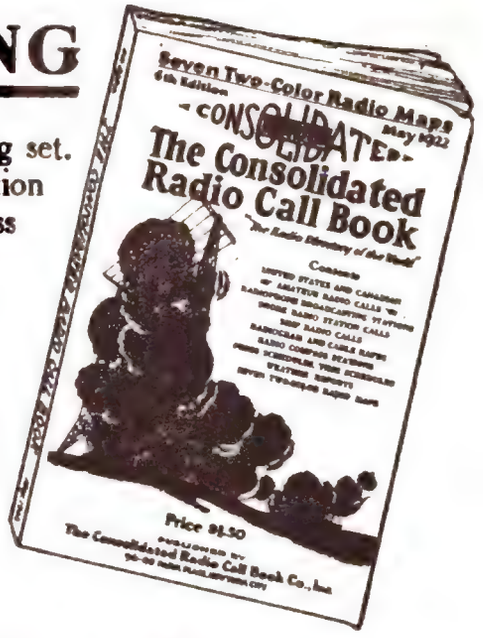

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Radio for the Beginner

By ARMSTRONG PERRY

(*Continued from page* 54)

thing the novice encounters is the fact that there are soft tubes and hard tubes. They feel as much alike as a pair of china eggs and the terms seem ambiguous until he finds out that they refer to the invisible insides. The emptier they are, the harder they are. The introduction of gas, which is put in in place of air, partly because air hastens the burning off of the filament, makes the tube softer, helping the flow of current between the metal parts. Soft tubes give better results than hard tubes, as detectors, but are likely to have a shorter life. The more perfect the vacuum, the longer the filament lasts.

There are about a dozen varieties of American-made electron tubes used as detectors. They differ in design, though all have the same three elements inside; namely, filament, grid and plate. In some the filaments are coated, with thorium oxide or some other oxide, which assists the discharge of electrons and to a small degree retards the burning away of the metal. Usually the filament is encircled by the grid, or is close beside it, and the plate is a cylinder that surrounds both. One type has the plate outside the glass tube. In attempting to place the three elements in the most efficient relations to each other, manufacturers have employed the highest priced engineering talent on the market. So sensitive is the device, that changes that appear to the layman, too small to make any possible difference in the operation of the tube, have had most important results.

Filament voltage was standardized for a long time at 4 to 6 volts. To secure that voltage, with enough amperes back of it to heat one or more tube filaments for periods of forty to eighty hours, the storage battery is necessary. Such batteries cost so much, weigh so much and need so much recharging that radio engineers recently designed low-voltage tubes that can be operated with a single ordinary No. 6 dry cell, thus meeting a tremendous popular demand.

In all types of tubes, considerable individual variations are discovered by the user. Like Ford cars, each seems to have a certain personality. Those aristocrats among radio bugs who can afford to have a dozen or more tubes usually have a favorite that is tenderly cared for, used only when special stunts are in progress, and is mourned long after it succumbs to the inevitable and goes "dead."

Some types of tubes are more critical than others. One type will operate successfully while the filament voltage is changed considerably by the manipulation of the rheostat, while another may demand the most accurate adjustment of the voltage.

One beginner bought two at one time that never brought in a signal until he had had them for months. The dealer had prepared him for this experience by telling him that they were critical on the plate voltage. They were "spares" so, instead of discarding his untapped "B" battery, which operated the tubes he was using successfully, he tried out the new tubes from time to time and waited for the battery to run down and adjust itself to the tubes. One night the new tubes began to bring in the signals and proved to be just as satisfactory as the others. When a new "B" battery became necessary he bought one with taps for adjusting the voltage.

Some tubes burn blue when the plate voltage passes a certain value. This is not a dangerous symptom, if the voltage is immediately reduced so as to bring the tube back to normal. While burning blue, the tube re-

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fuses to do much of anything else. The complaint it pours into the ears of the operator indicates plainly that it is in pain from the overdose of juice.

The gossip of the fans around the radio counter concerning tubes is interesting, and sometimes misleading. By listening long enough it is usually possible to find partisans of all the tubes on the market. The dealer's advice may, of course, be prejudiced by his contracts. Dealers are being sewed up to some exacting terms these days. On the other hand, the electron tube business is in such strong hands that greater danger lies in the purchase of tubes illegally manufactured and sold than in any choice that may be made among those manufactured by concerns that have the right to make them. The "boot-leg" tubes, as the illicit ones are called, may accidentally be good in rare instances, but the chances are against them. One illegal concern is reported as having matters arranged by a shrewd lawyer so that by changing the alleged ownership of the factory every few weeks it will be able to continue its business for a year or more before the axe falls. Once it was run in the name of a minor without his knowledge or consent.

The public interest in the new low-voltage tubes is at a high pitch just now. Every radio paper is deluged with inquiries as to what these tubes will do, and how to install them. The answer, so far as present experience goes, is that they will do almost anything that the older types will do, and will work in most of the circuits commonly employed in receiving apparatus sold to the general public. The filaments of these tubes are exceedingly delicate, but are so well made and carefully mounted that they are shipped and handled with as small a percentage of breakage as tubes that apparently are more rugged. These low-voltage filaments do not glow brightly when brought to the proper temperature, and that gives them longer life. The elimination of the storage battery, which they make possible, is considered an advantage by many beginners, for it saves expense and makes possible good receiving outfits that can be easily carried from place to place.

One beginner burned out his first low-voltage tube within an hour. The reason for its shortness of life was not apparent at first, but after consulting experts he decided that it was due to the installation of the tube in a horizontal position. He was using it in a receiving set designed for the older types of tubes, where the socket was horizontal. He purchased an adaptor and put the low-voltage tube in the proper position. It seemed probable that the filament, when heated, sagged against the plate and burned off.

Briefly, the things to be considered in the selection of a tube are these: (1) Was it made by a concern that had the legal right and the proper equipment to manufacture it? (2) Has it the highest possible sensitivity and the shorter life that ordinarily goes with it, or less sensitivity and longer life? and which of the two meets the requirements of the buyer? (3) Does it require a storage battery for lighting the filament or can it be lighted with a dry cell? Which is desired.

The tube sockets in most receiving sets sold in this country will take most of the American receiving tubes, though the new low-voltage tubes require an adaptor when used in sockets made for other types of tubes. The WD11 tube with special base is no longer manufactured, its form having been changed and it is fitted with a standard base; it is known as WD12.

Amplifier tubes are less critical in adjustment, harder as to vacuum, and longer lived than detector tubes. Some tubes can be used either as detectors or as amplifiers. If that seems desirable to the purchaser, he should ask for tubes of that type.

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Popular Astronomy

By ISABEL M. LEWIS, M.A.

(*Continued from page* 16)

of luminosity is surrounded by an extensive nebulous envelope which in some instances has been known to remain for years after the outburst has subsided. Nova Persei, the brilliant nova that appeared in 1901, and Nova Aquilae No. 3 that appeared in 1918, still have these nebular attachments very much in evidence on photographs that were taken long after their splendor had faded away. It is impossible to say, though, whether these nebular surroundings are produced by a sudden expansion of the star's atmosphere and the expulsion of gaseous vapors from the star's surface as a result of the sudden, abnormal increase of radiation pressure which would accompany the tremendous increase in luminosity of the star, or whether it is the dusky nebula, into which the star has run, illuminated by the light from the star itself or by electrical excitation.

One fact that seems to be assured in every case is that the star itself survives the catastrophe. The disturbance is confined to the surface and atmosphere of the star and to its immediate surroundings. If our sun is to pass through the nova stage we may feel certain that it will come through the experience with nothing more than surface changes or a slight permanent drop in radiant energy. As to the effects of the catastrophe upon its satellites, we cannot speak so optimistically. If our sun should suddenly pass through the nova stage of its existence it would mean the end of the world in the twinkling of an eye, the destruction of all living creatures upon the earth and any other inhabited planet, and the utter and immediate extinction of all vegetation by the burning heat of a sun whose radiant energy would be increased many hundred- or thousand-fold in a few brief hours. The fair face of our planet would become seared and blackened, as by the passing of a mighty all-enveloping fire and the oceans would disappear in rapidly evaporating clouds of vapor. No more complete destruction of the earth could be pictured by the theologians of olden times, who delighted in predicting the end of a wicked world, than would actually take place if our sun should pass through the experience that has probably fallen to the lot of most stars in the heavens at some period of their existence. Whether the interiors of the planets as well as their surfaces would be transformed by the sudden, tremendous increase in radiant energy that is characteristic of a nova is less certain. The nebulosity that surrounds the sun immediately after the catastrophe, whether an extension of the solar atmosphere or a dusky nebula reflecting the light of the sun, or excited to luminosity by it, would envelop all of the planets of the solar system, and it is possible that if the sun should become a nova its planetary system would be entirely remade from the material of former worlds and the surrounding nebulosity.

To bring complete and utter destruction to all forms of life upon the surface of the earth, and to transform our globe into a seared and blackened ruin, it would not be necessary for the sun to acquire more than a small fractional part of the tremendous outburst of radiant energy that is characteristic of a nova. We have said that many novas have been known to show considerable fluctuations of brightness before the final outburst has taken place. Any fluctuation in the

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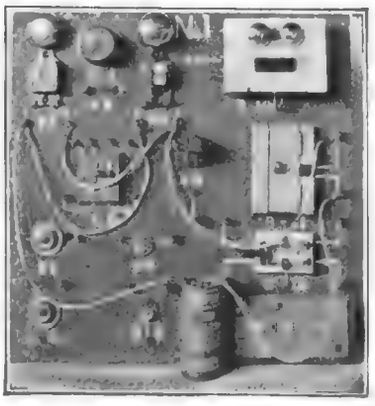

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brightness of the sun amounting to several hundred per cent of its normal output would be quite sufficient to destroy all forms of life that exist on the face of its planets as if by the scorching breath of a passing prairie or forest fire on a tremendous scale. The average nova attains a luminosity that is many hundred times its normal brightness. Nova Aquilae No. 3 acquired in a few brief days an increase of more than sixty thousandfold in radiant energy. An increase of less than ten-fold in the luminosity of the sun would be amply sufficient to destroy all life and to blacken the face of the earth.

At the present time the sun indulges in slight irregular fluctuations of brightness amounting at the most to less than twelve or fifteen per cent of its normal output of energy. It is possible that in the past it may have gone through more noticeable fluctuations of brightness, sufficient, some believe, to have caused the cycle of glacial and inter-glacial periods that are known to have occurred in past ages. On the whole, however, Old Sol has been remarkably kind to his satellites and remarkably even in temper, having indulged in no abnormal outbursts in the past billion years, if we are to accept the evidence preserved in the surface rocks of the earth's crust. According to the statements of the geologists, no abnormal changes such as would result from a many-fold increase in the sun's luminosity have taken place on this planet, since the earliest geological ages of at least a billion years ago. During this period the process of evolution has progressed uninterruptedly upon the surface of the earth, either because the sun has possessed a firm control over internal forces or because it has steered its family of satellites so skillfully through the universe of stars to which it belongs, that all encounters with cosmic dust clouds, meteoric swarms, or stars, luminous and extinct, have been safely avoided. During the comparatively recent period, a few million years at most, within which human life has existed upon this globe, the temperature of the earth could not have differed greatly from what it is today. During the ice ages the average surface temperature of the earth must have been comparatively low, but not fatally so. So sensitive is the human race to its environment and so narrow is the range of temperature which it can withstand, that a sudden change of two hundred degrees or so in the earth's surface temperature would bring about its destruction. Yet such a variation in the earth's surface temperature would be brought about if the sun showed a fluctuation in brightness no greater than can be observed in thousands of variable stars. It is by no means unusual to find a star varying irregularly in brightness by as much as several hundred per cent of its average brightness instead of the ten or fifteen per cent that is observable at the most in the case of our own sun. It is true that the sun is a variable star, but its range of variability is so small that its effect upon the earth's temperature is practically negligible. How long the sun will pursue its journey through the universe free from disturbances either from without or within is a question. The sun, like the human race, is getting on in years. It doubtless passed the peak of its glory many billion years ago and is now on the downward path, a small

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dwarf star of great density, on the way to extinction. So far as man can tell, it shows no signs at the present time of unusual activity, above that of its normal sunspot period of increased activity, and though vast cosmic clouds abound on all sides at no great distance from the solar system and might conceivably bring about its destruction, there is little cause for apprehension on this score.

It is more than probable that the sun will continue to shine with its present splendor undimmed and that the earth will continue to be a suitable abode for life long after the human race has passed away through self-destruction or as a result of its own follies, though there exists the possibility of the destruction of the human race and the end of the world for this planet by forces that lie far beyond our control. It is in the passage of the sun through the nova stage that we see the possible end of the world through the operation of such forces at some future date.

Old Time Optical Instruments

By T. O'CONOR SLOANE, Ph.D

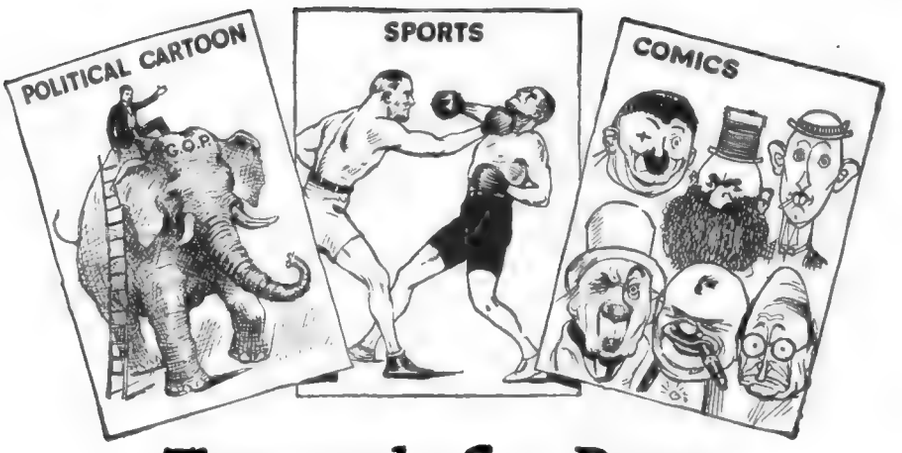
(*Continued from page* 15)

not even have a chimney, and Argand had not yet invented the central draught lamp. Another feature about the old magic lantern was that it was not contained in a case; the general idea was to divide a room in two parts and have the lantern in one part and the audience in the other. There is little doubt that this lantern, which was probably constructed during Father Kircher's lifetime, was one of the most esteemed articles in the museum.

We also illustrate a microscope, and here the reader will be interested to see what is almost a reproduction of the simpler type of microscope of the present time. There is a barrel supported on its base, to be looked through, carrying the lenses which latter is provided with a stage to carry the slide, and what is very interesting, sub-stage illumination seems to be provided for by the opening in the base. Just as in the case of the magic lantern, the very clear pictures tell their story.

And finally we show another object from the same museum, a description of which is given in a Latin caption below it to the following effect: "A machine for the desired firm support and convenient use of the large sized telescopes, a system hitherto lacking and invented and used by the Reverend Father Giles Francis, S. J. of Goettingen." This amazing telescope may be regarded as one of the predecessors of the Mt. Wilson instruments, and if we take the man as being of correct relative size, the telescope was truly gigantic. A scale of dimensions is given in the corner of the picture, and would indicate that it was thirty-five to forty Roman palms in length, which is about twenty feet. So it would seem that our little man should really be somewhat larger. What we have illustrated goes back about two hundred and fifty years. Father Kircher died in 1680 and the book from which these illustrations were taken is dated 1709.

In one of his works Father Kircher tells of someone who traveled about exhibiting pictures with his magic lantern, which was one of the novelties of that epoch, and the credit for its invention seems unquestionably to belong to him.



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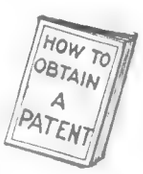

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HOOK'S PERPETUAL MOTION—PRO AND CON

(707) George H. Hook, Salina, Kansas, writes: I am sending herewith a photograph of a wooden model of a perpetual motion machine which I have invented and a newspaper clipping, and would like to know what is wrong with the machine. The wheel at the bottom of the trackway 20 inches below the center is raised by a force delivered 10 inches from the center, and upon reaching the center becomes neutral. The question is, does it take as much power to raise that wheel and weight from the position below the common center by a force delivered 10 inches from the center as the same wheel and weight would develop in descending the same distance 20 inches from the center.

He then says that the photograph is not complete as he does not wish to expose the entire machine and he will explain what the photograph does not show, and continues with his explanation. He states that the reason he failed to make the machine operate is because he had neither time nor money. To this letter we replied requesting further information in the form of a diagram. Mr. Hook answered this communication by stating that he did not think a diagram was necessary, and then elaborated on his previous description, making it evident that we were to answer yes or no to the question above alluded to, namely, whether or not a weight dropping 10 inches located twenty inches from the center would develop more power than a weight being raised 10 inches located ten inches from the center. Mr. Hook then mailed circular letters to his friends, stating that we were unable to reply to his perpetual motion machine theory because it was, to his way of thinking, without a doubt a positive project.

A. 1. If we say yes to the inquiry as given it is evident that we would be claiming that Mr. Hook had actually developed perpetual motion. It is evident that we can say neither yes or no to the question directly as given. Naturally, a weight dropping 10 inches and located twenty inches from the center will raise another weight 10 inches, but ten inches from the center; we certainly do not believe that Mr. Hook has designed a machine wherein a weight will drop this distance repeatedly as the machine oscillates or rotates. We do not desire to accuse Mr. Hook of attempting to use our letter for publicity purposes, but in view of the fact that a multigraphed letter of this nature reached us, we would be so impressed. We wish to advise Mr. Hook, as well as all perpetual motion enthusiasts, that no perpetual motion machine has been designed up to the present time, in which the reason for its non-operation cannot be given; in other words, reasons why any perpetual motion machine will not operate can be stated always. If the inventor refuses to disclose certain features of the invention, or if he sends a little snap-shot photograph of the model, it is of course impossible to give an explanation unless the photograph is at least lettered and labeled.

It is unnecessary for anyone to make an elaborate drawing. Several rough pencil sketches would suffice. The parts referred to should be labeled. The inventor of the aforesaid perpetual motion machine did not label parts, neither did he describe his machine so that even those versed in mechanics could understand it. He further distinctly specified that portions of the machine had been omitted as he does not desire to disclose the entire details, consequently, we will make this proviso. If the perpetual motion machine of Mr. Hook operates we will feature the same on our front cover. We will further reimburse Mr. Hook for the cost of his model provided that his machine operates, so that if he develops the machine to such an extent that it will actually function and continue to do so without additional assistance, just employing the falling weights, the machine will cost him nothing to build. To those who desire information on perpetual motion machines, we would suggest that their drawings should be explanatory enough to warrant serious consideration, and we will disclose those devices to no greater extent than we have disclosed the details of the machine in this description of the machine invented by Mr. Hook. Our confidence in the non-operation of the device is given in our challenge.

RUBBER STAMP AND ROTARY GASOLINE ENGINE

(708) Howard K. Knapp, Rushville, Ill., asks whether or not he can obtain a patent upon a rubber stamp having a curved base and also if we deem it advisable that he patent a rotary gasoline engine.

A. We doubt very much if a patent upon a rubber stamp with a curved base could be secured. A patent search would determine this. This can be made by any reliable attorney at a reasonable cost.

With reference to rotary gasoline engines, we would advise that there have been a great many of these patented. In fact, about three hundred different rotary gasoline engines have been designed and are covered by patents issued by the U. S. Patent Office at Washington. One of the best of these is the Tesla rotary gasoline engine.

There are several concerns in the West that are actually building rotary gasoline engines, but few if any of these have found a market, and unless the rotary gasoline engine is unique in design and remarkably efficient, we doubt very much if you will ever be able to place your idea before the public.

WATER TRACTOR.

(709) A. Kurzawski, Los Angeles, Cal., has designed a water tractor having a belt with a group of paddles mounted thereon. He also submits a drawing for an oil lantern having a glass guage on the outside to indicate the height of the fuel. He requests our advice.

A. Your water tractor is, we will admit, a little more efficient than the regular water wheels, but very slightly so, due to the friction on the part of the sprockets and chains. It would be much better to parallel several water wheels, or connect them in a series formation, one in back of the other, than to attempt using your method.

A guage on the side of lanterns is not a new idea. The reason it is not put in these positions is because of the added cost of such lanterns. Some lanterns are equipped with a moving scale to denote whether or not they are full. Particularly is this true of oil stoves. We doubt if a patent upon either of the two ideas would bring any worth-while financial return.

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RHEOSTAT

(710) F. Keagle, Highland Park, Ill., submits a sketch of a rheostat for a radio panel, which operates vertically instead of on the rotary principle. A switch blade makes contact on an arc sector wound with resistance wire, adjustment being made by pulling on the lever. He desires our opinion on the same.

A. We will admit that your rheostat occupies less space on the front of the panel, but this advantage is practically eliminated because of the extension of the rheostat at the back of the panel. Furthermore, a rheostat of this nature has two moving parts, through which contact has to be made, adding greatly in this manner to noises produced in amplifying tube sets.

In addition to this, the device presents no method of determining the position of the rheostat arm. It further is extremely difficult to mount on a panel, and if it should eventually become but slightly worn it would probably drop into the full "on" position even when not desired.

We would advise against endeavoring to patent this device, mainly on account of the difficulty encountered in mounting the same.

Money for Your Ideas

(Continued from page 58)

of the screw. Or, again, it may have been the crossover problem in the early trolley car, in which the current collector ran along on top of the wire, a problem which was solved by the simple expedient of running the collector wheel on the under side of the trolley wire.

The strangest part of it all is that many of us try so hard to do the thing in a difficult way, and without success, when it could be quickly done if it were tried in the easiest way. Thus, in the problem of projecting motion pictures on a large canvas, it was but a very simple thing which unloosened the flood of motion picture theaters and added a new industry in which many millions are already invested. Workers in different parts of the world had labored diligently on the problem, but to no avail. Success, so far as it went, had been confined to very small pictures, exhibited in dark boxes into which one looked through a proper sight opening. Yet, when the pictures on a large canvas came, it was discovered that all that had been done, which had not before been done by many others, was the simple step of enlarging the light opening in the rotating shutter of the machine. That simple invention was due to Mr. C. Francis Jenkins, of Washington.

OPPORTUNITIES FOR INVENTORS

Each new invention breeds a host of appurtenant inventions. When the telephone was invented, for example, it became necessary to invent the switchboard, party line circuits, battery systems, in a word, a thousand and one inventions, without which it would be difficult if not impossible to telephone from New York to Chicago. Mr. Charles Scribner has taken out about 900 patents on telephone systems alone, which shows how vast is the field which is opened when a pioneer invention is introduced. The same applies to the steam locomotive, to the steamboat, to the harvesting machine, to the gas engine, in a word, to every invention, great or small.

The McKay sewing machine patent for manufacturing shoes became the central power in one of the greatest monopolies of the world. Over ten million pairs of boots and shoes made in America annually pay royalty to this company. Yet McKay peddled the stock of his first corporation from door to door among his friends in Pittsfield selling it by force of circumstances to the poor cotton workers of Lowe[illegible] Lawrence and to the hardy whal[illegible]on of New Bedford. The de[illegible]e first dividend found t[illegible]lthy, with still greater

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Dr. Hackensaw's Secrets

By CLEMENT FEZANDIE

(*Continued from page* 18)

feet, and could furnish an inexhaustible supply of water."

"But the sea-water is salt!"

"I should distill the water. The volcano would furnish me, free of charge, all the heat I should need for the distillation, and from the salt left as a residue I could obtain sodum, potassium, other elements, and possibly gold in greater or less quantities."

"But you couldn't make the water run uphill to the volcano!"

"Why not? I should pump it up. At the start I should have to use coal to pump up the first supply. But as soon as this was converted into steam I could use this in a steam engine to pump up more water to make more steam, etc."

"I see. Perpetual motion?"

"Not quite. You forget that I have the stored-up energy of the red-hot lava to replace all the power I use in pumping—and enough to spare to run all the railways, street cars and factories in Naples; for heating the houses in winter, cooling them in summer, and . . ."

"Hold on a bit!" interrupted Silas, pleased to think he had caught the doctor napping. "How could you use *heat* to cool a house?"

But Doctor Hackensaw merely smiled as he answered: "All our large refrigerating plants use the 'ammonia process' for cooling purposes. And though it may appear paradoxical to you, it is the *heat* that produces the *cold*. The heat evaporates the ammonia, and the ammonia in evaporating produces cold. I plan to make the heat of Vesuvius serve to keep the houses and streets of Naples cool, even on the sweltering hot days of their hottest summer weather. Nor shall I stop at Naples. Rome is not too far off to benefit. So far I have only spoken to you of hot water. But my main reliance will be on electricity. I intend to build huge power stations on Vesuvius, run my dynamos by steam produced by the internal heat of the volcano, and transmit this electricity by wire to the various Italian cities. By using a high potential there will be no difficulty in furnishing Rome as well as Naples with heat, light, power and refrigeration. Every house can have an unlimited supply of current at a trifling cost."

"You're a lucky dog, doctor, to be able to make a trip like this. I wish I were going along with you!"

"What? And leave Gloria Mundy here in New York, to pine for you during your absence?"

Silas Rockett blushed. "The fact is," said he, "Gloria is the friend I came here to see. She is sailing on this boat today. She is going through Paris to Venice and Rome."

"Then, Silas, why don't you come along, too?"

"I wish I could, but I can't; I've got my work to do for the *New York Daily Growl*."

"Nonsense! You know the old proverb: 'Pleasure won't wait for you, but duty always does. But I have an idea. The boat doesn't start for fifteen minutes yet. Telephone to your newspaper, tell them my plans, and ask permission to accompany me. You can promise your editor some sensational scoops!"

"But I haven't any ticket, no clothing, and not a cent in my pocket. Besides, there's not a vacant berth on the ship."

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Edison says: "Invention should be taught as a profession." Every inventor realizes the hopelessness of groping in the dark for the habits of thought and methods of work required for successful invention. Trying to invent without knowing the fundamental requirements of invention is like trying to build a bridge without knowing engineering.

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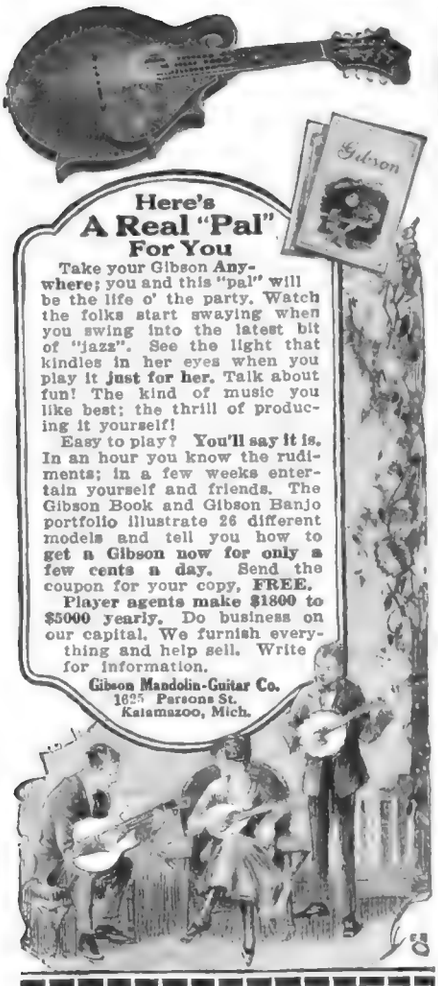

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"Oh, a reporter can always manage. He ought to be able to travel with a toothpick."

"But I haven't even got a toothpick!"

"Never mind—just telephone. I'll buy your ticket and you can have the spare berth in my stateroom. As for clothing I'll get you a set of sailor's togs from the ship's slop-chest! How would that suit?" And Doctor Hackensaw leaned against the boat's rail and guffawed.

* * * * * * * * * *

A few weeks later Doctor Hackensaw was installed upon Vesuvius superintending operations and busy as a bee.

"My first step," he explained to Silas, "must be to ascertain the exact location of the liquid lava inside of the mountain. For this purpose I have had a number of preliminary borings made. I must be careful not to drill these holes too deep or I should tap the red-hot lava. But the temperature in the bore gives me ample warning."

"Why do you need a map of the liquid lava?" asked Silas.

"So that I may know the best place to lay my pipes. You see, my object is not so much to get free heat and power for Naples as it is to tame Vesuvius and prevent future eruptions and earthquakes."

"How *can* you prevent them?"

"By affording a free outlet to the internal forces. Earthquakes are due to one of two causes. Either the imprisoned gases in the volcano cause an explosion and set the earth trembling; or else the lava ejected from the volcano leaves hollow spaces underground and the crust of the earth falls in. Now, if I succeed in carrying away the heat from the interior as fast as it is formed, the gases will cool and not explode; the lava will not be ejected and no vacant spaces will be formed. I shall thus prevent both the eruption and the earthquake."

"I see."

"Of course, I must be careful to leave free outlets for the gases and lava. If I should cool the lava in the outlet itself, I might block up the safety valve and the result would be that the imprisoned gases would cause an explosion such as the crater has never before experiencd!"

The day following this conversation, Silas Rockett was sitting in the hotel-cafe in Naples with Miss Gloria Mundy, when Doctor Hackensaw appeared. The doctor's face was grave.

"What's the matter, doc?" asked Silas, cheerily, for the fact that he was paid by his paper for spooning around with a pretty girl on a tour through Europe, made him see everything through rosy spectacles. "Is there any hitch in your operation?"

"Hitch is no name for it," returned the doctor, gloomily. "It looks as if my whole scheme would fall through. I've just been up to the observatory on Vesuvius and had a long talk with one of the staff there. He showed me the spectroscopic views of the flames, and the graphs made of the perturbations in the volcano. He also informed me that the scientists there are convinced that there is another eruption of the volcano imminent. It might come in three months' time, or it may be delayed for a year or two and then occur with greater violence. But come it surely will, within a few months' time."

"What if it does?"

"Don't you see that it will upset all my plans. An eruption, with its accompanying earthquakes, is sure to destroy the greater part of my work."

"I see. And all the money you put into the enterprise would be lost?"

"Bosh!" snapped the doctor. "I should be willing to put ten to twenty million dollars into the venture even if I were certain of getting none of it back. But I don't want to just throw the money away."

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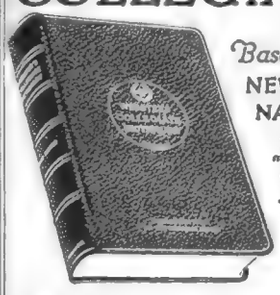

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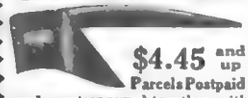

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"Then, said the reporter, jocosely, "I suppose all there is to do is to stop the eruption!" And he leaned back, smiling, for Gloria was charming that day, and life seemed well worth living to Silas Rockett.

"Stop the eruption?" echoed the doctor, his face brightening. "That's not such a fool idea of yours as it sounds, Silas. I'll have to study up the question."

A week later when Silas and his fiancee returned from an excursion to Capri and the Blue Grotto, they found Doctor Hackensaw restored to his usual spirits—more exuberant than ever—perhaps.

"I think I've solved the problem, Silas," he shouted, "or rather, you solved it for me. I'm going to stop the eruption!"

"Oh, indeed?" grinned Silas. "Well, if my idea proves valuable, you'll have to add me to your staff of professional advisers. I suppose you're going to order Vesuvius to keep quiet. But do you happen to know the address of the manager, and are you going to write or telegraph or wireless him to stop the eruption?"

"I'm going to use the wireless," returned the doctor, serenely, "or rather, I'm going to ask Miss Gloria to use it for me."

No more would he say for the moment, but for the next few weeks he was such a busy man that Silas saw very little of him. In fact he spent most of his time at the crater. He had cautioned the reporter not to say a word in regard to his plans.

"If the Neapolitans got an inkling that I was going to take liberties with their volcano, I should be mobbed. There is superstition everywhere, but the people living on a volcano have more excuse for their superstitious fear than any others."

Doctor Hackensaw had already obtained governmental permission for his preliminary borings. He had not revealed his real plans, but had declared his conviction that immense deposits of sulphur must exist somewhere in the mountain, and had obtained permission to hunt for them. This, and liberal tips to his employes' enabled him to carry on his operations without hindrance. Things progressed rapidly, and one day he came to Silas and cried jubilantly:

"All's settled, Silas. I've ordered the eruption for noon—two weeks from today."

"What!" cried Silas in mock astonishment, "you're going to let the volcano shoot, after all? Didn't I tell you to stop the eruption?"

"You did, Silas, but I found the contract was a little too much for me to handle, so I've made a compromise, The eruption was bound to come, so I thought it better to make it come at a definite date, and limit the extent and direction of the lava flow. My borings have enabled me to locate the spot where the pent-up forces are at work, and special instruments have helped me to ascertain the internal conditions. After careful study, I decided to create a weak spot in the crater, so that when the explosion comes, the lava will flow off in a direction secure from danger of doing harm. I don't want to run the risk of covering up Pompeii again or of destroying any other city. My workmen have been busy creating this weak spot, and now all is ready for the eruption."

"Whew!"

"Of course I have not made public the fact that it is I who am creating this explosion. I have notified the public through the newspapers that an eruption and earthquake are due at noon-time, two weeks from today. To avoid all possibility of accident, the police will clear the people from the surrounding villages on the day of the eruption, and all persons will be warned to seek open spaces, so that no one will be injured in case the earth tremors are strong enough to knock down any buildings."

"How are you going to start the volcano going?" asked Silas.

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The two weeks dragged slowly by, but the eventful day dawned at last. Every precaution had been taken to prevent accidents.

At noon on the appointed day, Doctor Hackensaw led Miss Gloria Mundy to the wireless instrument in Naples, from which the etheral wave was to be sent that would explode the TNT and start the eruption. The spot faced the bay and the smoking volcano could be clearly seen on the other side of the water.

In the very focus of the movie cameras, Miss Gloria, more beautiful than ever, and trembling a little at the importance of the rôle she was about to play, pressed down the control-switch just at the stroke of twelve.

Instantly a cloud of flame and smoke was belched up from the volcano, huge blocks of lava being hurled up high into the air. It was only several seconds later that the report could be heard, for sound travels far more slowly than light.

The earth shook violently and several ramshackly buildings fell. Some window panes were broken, although people had been warned to leave the windows open to avoid such breakage.

The deed was done. Vesuvius, for the first time in its life, had found a master.

It was some months later before the doctor was able to carry out his initial project, and he never completed it fully. But he did eventually succeed in furnishing the people in Naples light, heat, and power at ridiculously low prices.

Hunting Criminals in 2000 A.D.

By FELIX LEO GOECKERITZ

(*Continued from page 20*)

But now—he listened in astonishment—over the wires came the sound of steps. Shots came next, could the robber have escaped with a sudden dash? Brillov pressed upon a white button. He closed all the doors of the building by electric telemechanics. There was no escape.

Brillov again listened. The policeman—he knew that the Central Office could understand every word he said—cried out loudly against the walls: "When we entered this steel chamber, the burglar threw a smoke-bomb. In the impenetrable smoke he managed to get by us and got out before the cage door fell. The officer in front of the steel cage took up the pursuit at once, but scarcely had the burglar reached the rear door, when the door of the cage fell in front of us." Lieutenant Brillov pulled the white knob back which opened the door of the cage again, and bit his lips in irritation—*he himself had rescued the robber from his pursuers.* Then he connected the wireless telephone to the police telephone post, which stood in the side street next to the bank.

The officer felt suddenly a weak electric ticking at his temples and jerked the little telephone to his ear: "Officer No. 381 on night watch"—"Listen," said Brillov, "The Bank of Commerce is broken into. The burglar has escaped out of the rear door. He must pass your station; catch him whatever happens and if necessary shoot." The policeman repeated the order to himself and then looked out peeringly through the darkness. No pedestrian was to be seen, only an automobile approached him at high

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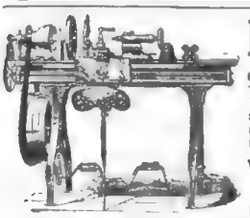

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speed. The officer drew his revolver and gave a warning shot. In response, the automobile doubled its speed. The officer sprang to one side and pulled out the handle which by electric action, drew a steep barricade across the street crossing. The burglar was not going to escape him whatever happened.

But what was that? Two great springs appeared suddenly on the bottom of the automobile which lifted it up, and it jumped as if it was a running horse, over the barricade. Before the officer could recover from his astonishment and give a shot, the automobile had disappeared in the darkness of night.

Lieutenant Brillov cursed wildly as he learned of this. He at once alarmed by wireless all the police posts of the city, but the replies gave no comfort. The automobile was nowhere to be seen. He turned loose all the police automobiles, the whole region was covered at reckless speed—in vain. Only one thing remained, the airplane police station. A giant captive balloon, to which ready for instant flight, two monoplanes were attached. The answer came from them that a thick cloud prevented all out-look and airplane patrol would be useless.

Brillov began to rage. He knew if the burglar escaped that he would be removed from his position by the severe regulations of the department. Then suddenly the air-police station 11Z rang him up. Their wave indicator warned them of the presence of an airplane not regularly licensed. Brillov connected his own apparatus and his indicator marked on the card beneath it, a beautiful undulating line that lead to the north.

Telegraph and wireless telephones worked feverishly, but in all directions dense clouds were announced that made the pursuit impossible. The fugitives by this time were in the neighborhood of Hamburg, and finally the news came that a fleet of police airplanes were on their heels.

Now the sea lay bright and wide in the first rays of the morning sun before the fleeing burglar, as he suddenly descended in an abrupt volplane to earth, jumped out of his fuselage and hurried towards the shore. Automobiles began to appear out of the distance. Out of the air shots began to pour down on him. He ran with desperate speed. He reached the bank. Behind the piling there was a boat; hands were stretched out to him from it. He jumped on board and sunk powerless to the bottom, when the boat with the speed of an arrow, sank to the bottom. And now, half fainting, he proudly laughed. The burglars themselves, it seemed, were well organized, and the millions of plunder in 100,000 mark notes were stowed away in his knapsack, resting lightly on his shoulders . . . .

A police automobile appeared on the scene. The young lieutenant put a glass to his eyes, and looked closely over the surface of the water. Nothing. He gave the alarm to the submarine police by wireless—the apparatus was built skilfully into the auto. In a few minutes with a delicate sound measuring apparatus the fleeing submarine was located.

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(*Translated from the German.*)

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You can't continue to make a success of your business or your work when you wake up head-achy, out-of-sorts, filled with lassitude that makes the tackling of each job a task. You never will be picked out for promotion if you do each day only what you have to do; if you haven't the energy, ambition, mental alertness and physical stamina to make yourself stand out as a man of pep and power.

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Don't fool yourself with the idea that you will get better—unless you do something—or with the even worse delusion that patent medicine dope will ever bring back the virility you have lost. No pill, powder or potion ever put together can build the red blood and physical and mental material that makes a man. It never has been done. It simply can't be done.

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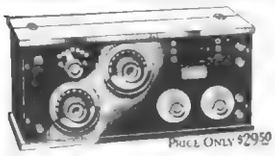

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Obtaining An Amateur Radio License

(*Continued from page* 46)

3. The apparatus shall at all times while in use and operation be in charge of a person or persons licensed for that purpose by the Secretary of Commerce, and the operator of apparatus shall not wilfully or maliciously interfere with any other radio communication.

4. The station shall give absolute priority to signals or radiograms relating to ships in distress; shall cease all sending on hearing a distress signal; and shall refrain from sending until all the signals and radiograms relating thereto are completed.

5. The station shall use the minimum amount of energy necessary to carry out any communication desired, and the transformer input shall not exceed one one-half kilowatt.[1]

6. The station shall not use a transmitting wave length exceeding 200 meters.

7. The station shall not use a transmitter during the first 15 minutes of each hour, local standard time, whenever the Secretary of Commerce by notice in writing shall require it to observe a division of the time, pursuant to the Twelfth Regulation of the act of August 13, 1912.

8. The President of the United States in time of war or public peril or disaster is authorized by law to close the station and cause the removal therefrom of all radio apparatus, or may authorize the use or control of the station or apparatus by any department of the Government upon just compensation to the owners.

9. The Secretary of Commerce and Collectors of Customs or other officers of the Government authorized by him may at all reasonable times enter upon the station for the purpose of inspecting and may inspect any apparatus for radio communication of such station and the operation and operators of such apparatus.

(*Continued on page* 87)

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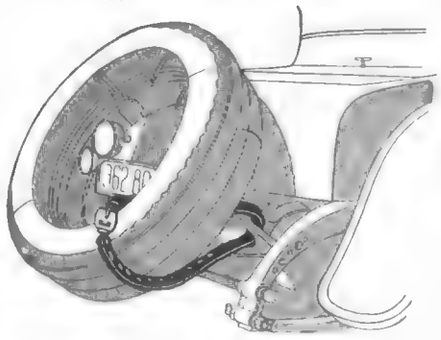

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65% Have This Gland Trouble ~At Middle Age

Do you suffer with sciatica, pains in back, legs or feet, frequent nightly risings, bladder or kindred trouble; have you lost the old pep and aggressiveness; do you have blues or mental depression?

Scientists and medical authorities agree that 65% of all men past a certain middle age (thousands younger) have a disorder of the prostate gland, often responsible for these annoying conditions.

Simple Home Treatment

But a new treatment has been discovered by a member of the American Association for the Advancement of Science. Already over 10,000 men have used this method with astonishing success. It has saved many of them from the surgeon's knife. Yet the method is so simple that it can be used by anyone —no drugs, lessons, electric rays. Nothing to pay unless you get immediate relief. If you have prostatic trouble, or any of the symptoms mentioned, **Free Book** send immediately for a Free Book, "Why Many Men Are Old at 40," which tells all about this method—and the truth about glands. No obligation. Just give name and address. Write immediately to **The Electro-Thermal Company, 4520 Main Street, Steubenville, Ohio.**

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A Man's Gun. Military Model, built for hard service, just like they used "OverThere." .32 cal. 10-shot, blue steel, safety attachment; No. 294 with extra magazine FREE, now reduced to..... **$10.25**

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Suite 309, 70 5th Avenue — New York City

10. **The apparatus shall not be altered or modified in respect of any of the particulars mentioned in the following Schedule except with the approval of a radio inspector, or other duly authorized officer of the Government.**

Name of naval or military station, if within 5 nautical miles, ...

*Power: Transformer input,.....W.[3]

Antenna: Type (T, ┐, etc.).

Height, ...; horizontal (above ground) length, ...

Wires: Number in vertical part,.....; in horizontal part, ...

The normal sending and receiving wave length shall be.....meters and the station is (not exceeding 200) authorized to use the following additional wave lengths, not exceeding 200 meters: ..... meters, ...meters.

This license expires on....., 19....

HERBERT HOOVER
C. H. HUSTON,
Assistant Secretary of Commerce

D. B. CARSON,
Commissioner of Navigation

Delivered by .....
(Radio inspector)

Place..... Date....., 19...

[1]Strike out "one" if the station be within 5 nautical miles of a naval or military station; otherwise strike out "one-half."

[2]Not to exceed 1,000; or if the station be within 5 nautical miles of a naval or military station, not to exceed 500.

*If vacuum tubes are used, power should be actual watts in plate circuit.

At one time it was a general idea that a radio transmitting station could be operated by an amateur, providing that the transmitting range of the same did not extend beyond the border of the state in which it was located. However, this is a misapprehension, the law covering this point reading as follows:

BE IT ENACTED BY THE SENATE AND HOUSE OF REPRESENTATIVES OF THE UNITED STATES OF AMERICA IN CONGRESS ASSEMBLED, That a person, company, or corporation within the jurisdiction of the United States shall not use or operate any apparatus for radio communication as a means of commercial intercourse among the several States, or with foreign nations, or upon any vessel of the United States engaged in interstate or foreign commerce, or for the transmission of radiograms or signals the effect of which extends beyond the jurisdiction of the State or Territory in which the same are made, or where interference would be caused thereby with the receipt of messages or signals from beyond the jurisdiction of the said State or Territory.

This is now construed to mean that a transmitting station must not interfere with any receiving station capable of receiving messages from other transmitting stations located without the borders of the state, in which the receiving station is located. Obviously, it is impossible for one in these days to operate even a buzzer transmitter without interfering with some station capable of receiving messages from without the borders of the state.

In addressing the prospective operators, Mr. Batchellor tells them of many complaints received regarding the actions of various amateurs in operating their transmitters, while others are listening to broadcasted concerts, etc. He stresses the moral obligation of the amateur to the broadcast listener, and makes a special request that each amateur, after his station is in operation, remain quiet during periods in the evenings when broadcasting is being done. No law covers this case, but, as Mr. Batchellor said, it is probable, if amateurs make a nuisance of themselves to the broadcast listeners, that the latter will take the matter to higher courts and have laws enacted curtailing the activity of the aforesaid amateur. We do not want this to happen, and therefore it is up to the amateurs to cater somewhat to the broadcast fans, the latter being in the majority, and having the most power legally.

So it is up to the broadcast fan to get into the game deeper and become a licensed amateur, and it is up to the amateurs to band together for their common good and suppress those of their brethren who persist in interfering with broadcast reception.

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You are offered the biggest opportunity of your life right now. You can't help seeing the tremendous boom that is now on in manufacturing and building. Never before such chances for technical men. Skilled draftsmen and building experts who can read plans, figure costs and boss big jobs are wanted at high salaries. No need for you to work for small pay or to remain in a no-future position when great industries are looking for men like you *with specialized training.*

Get Chicago "Tech" Experts Back of You

Don't put in years waiting for "your chance." Make your own chance. Let practical men train you by mail for a big job or your own business. Cash in on your spare time. You are actually wasting time in which you could easily get instruction that brings quick advancement and more money.

Chicago "Tech" Men Win

Rex Carey took Chicago "Tech" training in Draftsmanship and doubled his salary, then doubled it again. J. D. Woodside, working at a carpenter's bench took the Builder's Course and is now a prosperous contractor. O. S. Rosin became a successful architect in the same way. Everywhere you find Chicago "Tech" men in big positions or in successful businesses. They are always in demand because they are trained in practical methods.

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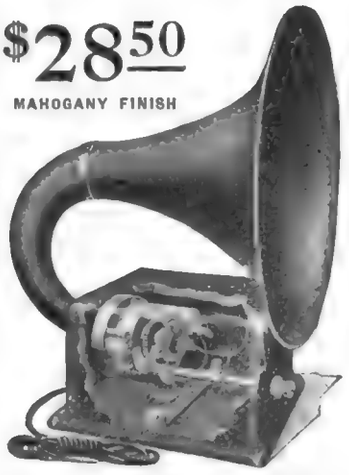

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With the Adjustable Air Gap

Overcomes the defects common to all other radio loud speakers—the harsh jarring sounds, the noises and overtones. It creates the illusion that the artists are in the very room with the listeners.

The DICTOGRAND RADIO LOUD SPEAKER is designed to operate on any vacuum tube receiving set giving maximum results when two stages of amplification or more are used. Requires no extra batteries. You simply plug in—and listen.

The DICTOGRAND RADIO LOUD SPEAKER, like all Dictograph products, is guaranteed for a period of one year against all electrical or mechanical defects.

Phantom View Showing the Adjustable Air Gap

consists of an adjusting dial mounted in front of the cabinet, by means of which the distance between the magnetic poles and the diaphragm may be increased or decreased, thus varying the pull of the magnet on the diaphragm and permitting tuning up in complete harmony under all varying conditions of reception.

ASK YOUR DEALER TO DEMONSTRATE IT

The unusual demand upon our facilities has not enabled us to complete our distribution. If your dealer has not yet received his stock of DICTOGRAND Radio Loud Speakers, send to us direct.

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Charges Both A and B Batteries

SELF POLARIZING—Connects either way to battery.

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The A C Charger is constructed of high-grade materials and always gives satisfaction. Scientific design by electrical engineers insures its uninterrupted service.

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Comes complete with charging cable, battery clips, attachment cord and plug. All ready for use with complete instructions for charging all radio A and B batteries.

Get the A C Charger at your dealer. If he does not handle it, send money order for $16.50 to factory with dealer's name, and A C Charger will be shipped promptly.

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They, the amateurs, must realize that they are in the minority, and that if popular opinion once raises against them their privileges will soon be taken away and we shall find ourselves, in regard to radio amateurs, in the same position as many of the European countries are today. This being a step backward, rather than in advance, it is our desire to maintain peace between these two factions for the mutual benefit of both.

The *American Radio Relay League* has done some very good work along this line, and all the members have pledged to keep out of the air between the hours of 7:30 and 10:00 P. M., thereby allowing the broadcasting stations to present their programs with a minimum of interference. Even this is not absolutely necessary if the amateurs use sharply tuned sets, and do away with the old "rock crushers" or spark sets, and install C. W. or radiophone transmitters. These latter, when used on 200 meters and lower, can be so sharply tuned that they will create practically no interference with receiving sets listening in on 360 and 400 meters.

Fireworks Photography

Written and Illustrated By WILLIAM P. SIPES

(*Continued from page* 40)

shell will be shot into the air. But there is always a burning fuse attached, watch for this with the eye, and as soon as you see one, why locate it in your view finder, as it moves upward move your kodak up also, keeping the lighted fuse about ⅔ of distance up from bottom. When shell explodes the fire will drop downwards.

On your next operation depends your success or failure. Be all attention to what you are doing. As soon as you see the shell begin to burst open in view finder, give the thumb screw a quick gentle turn to lock it into position. (The kodak must not be jarred while locking it or it will blur and give a wavy effect in picture.) As soon as it is locked take right hand off of the bed, and press cable or bulb. (Your shutter should be set at "B" or bulb.) Hold this open until the fire has died out.

You must be quick in locking your thumb nut and opening shutter. I can have it locked and shutter open by time the shell opens full. This is the best part of it. If you are sitting on the ground, you can use a brick or a small box, wrap them with paper to avoid scratching. As the shell goes upward slide the bottom of camera away from you, letting back rest on the block behind it. As soon as shell begins to open proceed as above in opening shutter. If using a tripod without the optipod locate the shell by its burning fuse in finder. It is much better to do this before it gets too high, as you can follow its progress upward and center it better in view finder.

All colors will not photograph. So it is to be expected you will get some blanks. All large gatherings and State Fairs are putting on displays of this kind, and as so little has been known of this work in the past, it will be possible for anyone to take good pictures if you follow instructions.

The best point of view is in front or on one side about 300 feet from where fireworks are shot off. Many pretty effects are obtained, and because they are out of the usual in pictures, it makes it worth one's time in taking them. A small pocket flash light is ideal to locate film numbers in window on back of kodak while winding film.

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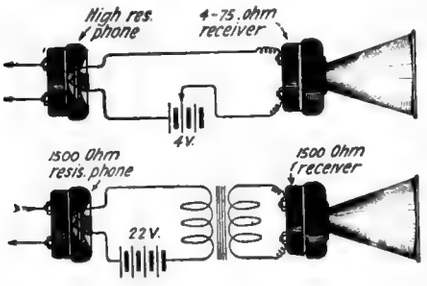
How to Hook-Up A Transmitter Button to Make an Efficient Loud Talker

A Transmitter button with a few dry cells and a telephone receiver will make a remarkably simple and efficient loud talker. A Microphonic amplifier of this type is just the thing for use with a radio set. The weak music and signals may be amplified many times their original value. It is possible to entertain a large audience with a simple radio equipment if a transmitter button is used in the circuit as explained in diagram A.

The cost is extremely low and the results are comparable with those produced by highest grade of expensive loud talkers.

As may be seen in the diagram, two dry cells or a small storage battery are connected in series with the transmitter button and a 4 to 75 ohm telephone receiver. The transmitter button is secured to the diaphragm of the telephone in the radio receiving set. To accomplish this properly, scrape off the enamel (if diaphragm is enameled) on the face of the diaphragm and solder the small hexagon nut supplied with the button to the exact center. Care should be taken that the thin diaphragm is not bent or otherwise



harmed. The transmitter button is then screwed into place. Connections, as shown in the diagram, are made with flexible wire. A horn may be placed over the low resistance receiver if desired. When the radio set is properly tuned and signals are being received, the transmitter button is operated by the vibration of the diaphragm of the receiver. As the receiver diaphragm vibrates, the mica diaphragm on the transmitter button also vibrates. The carbon grains are compressed at varying pressure; the current flowing through the local battery circuit is thus varied and results in an amplification of the sounds in the low resistance telephone loud-talker.

Diagram B, which includes a step-up transformer, is to be used with loud talking receivers of high resistance. The primary of the transformers should have a resistance of about 75 ohms. An ordinary telephone induction coil will serve as the transformer in this circuit.

You can get the above-described transmitter button FREE in subscribing to "Practical Electrics Magazine" at $2.00 per year (12 months). Send your subscriptions today.

Make all remittances payable to Practical Electrics Co., 53 Park Place, New York City.

—Adv.

How to Perfect the Phonograph

By BERNIE L. BEVILL

(*Continued from page 32*)

as in the ordinary machine. This record 4 is the size of the ordinary wax record, but is made of aluminum and coated with some material that is capable of receiving vibratory indentations and which must be a fairly good conductor of electricity. Such a material remains to be developed, as I have not experimented upon the matter. However, the chemist should not find it difficult to discover such a substance. It may be that a mixture of red lead and glycerine added to some wax base would be sufficient for the purpose. In case such a mixture could not be found that would serve this purpose, perhaps we could dispense altogether with the vibratory indentations and prepare a record containing a plating of some chemical that is acted upon by the electric current in such a manner that when the electric current is acting upon it it will tend to permit of more current passing where the greatest current passed at first and vice versa; that is, certain chemical differences will be found in the material that will correspond to the varying depths of the vibratory indentations found in the other kind of record. This arrangement will be very similar to the *telephoto* device, inasmuch as it carries pulsations to the receiving device corresponding to the impressions thrust upon it by the sending apparatus.

These pulsating currents are supplied by a rectifying transformer placed within the phonograph cabinet as at 9, which receives its current from the ordinary lighting circuit by being connected to the leads that supply the motor at 5. The pulsations are carried from the tungsten stylus at 1 through the record, and by metallic connections of the record with the turn-table, down through the main shaft of the motor, through the connection at 6 to the transformer and back to the electromagnet 8, which attracts the vibrating disc 7, causing it to vibrate in unison with the vibrations that caused the indentations in the record. Thus the sound is produced. The resonator, or horn, that is attached to the disc serves the purpose of intensifying the sound just as in the ordinary phonograph. By this manner of arranging the device, it can readily be seen that metallic sounds are entirely eliminated, for the scratching sound that is caused by the scraping of the stylus upon the record is prevented from reaching the ear by closing the top door of the machine.

Whether or not this apparatus will function properly when put into actual practice remains to be seen, but at least, the idea seems entirely logical. The theory is perfect in detail and if some enthusiastic and enterprising experimenter will give his attention to the matter, there is no reason why the invention should not succeed. It is comparatively speaking an extremely simple apparatus. It is only necessary to procure some old worn out phonograph, install an electric motor in it and proceed to commence experimenting. The metallic arm that serves for the purpose of the tone arm can be made with a little patience and the tungsten stylus can be purchased.

I am quite sure that such a phonograph would be a great blessing to humanity and should meet with the entire approval of everyone. Music produced by this device should be possessed of all the pure tonal qualities of the original rendition, as there would absolutely be no over-tonal effects produced to spoil the musical qualities and to grate upon the ear of the most sensitive.

There may be cases where a city lighting current may not be had. In this event, it is only necessary to procure several dry cells to supply the current.

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That Curious Device for Making Fire

IT was only seventy-five years ago that a woman of the Middle West wrote to her cousin in New York:

"Last winter I was told of a curious new device for making fire. It consisted of small splinters of wood with tips of some substance that bursts into flame when rubbed on a rough surface. If you can procure some of them for me I shall be grateful."

Matches were in general use in Europe for years before they were seen in this country. There was no means for spreading such news rapidly. Today, the new invention that contributes to comfort or convenience is quickly known the country over. Advertising conveys the information. The farmer's wife in Texas or Idaho is as well posted on these things as the city woman of the East.

Don't overlook the advertisements. They are heralds of progress, with real news for you and your family. They save your time, lighten your work and enable you to obtain the utmost in value for the money you spend.

Time given to reading the advertisements is well spent.

GENUINE GERMAN MAUSER

Half pre-war prices

$12.95

Latest model 9 shot automatic. Shoots standard cartridges—lies flat in pocket—World's famous Luger 30 cal. $20.75 — Hand Ejector Revolver, swing out cylinder 32 cal. $16.95. 38 cal. $17.95. All brand new latest models. Guaranteed genuine imported. Pay on Delivery Plus Po

SEND NO MONEY

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...cket Automatic; 25 cal. Blue Steel Army $8.45; 32 cal. $10.45; Officer's Auto... ties, 25 cal. $11.95; Military Trench 32 cal. 10 shot extra magazine FREE, ...st like you used over th ere. Imported Revolver. 32 cal. $8.65; 38 cal. $8.95. CO., 141 B'dway Desk 280 New York

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E. S. GIVENS, 168 Chemical Bldg., Kansas City, Mo.

Poisonous Gases Find Uses in Industry

By ISMAR GINSBERG

(*Continued from page 32*)

the past few years since the close of the war. An important use has been developed in the purification and sterilization of drinking water. This use is almost universal in the cities of our country. About 2025 cities, with a total population of 40 million people, consuming over four billion gallons of water each day, chlorinate their water before it is piped to the consumers. The largest chlorinating plant in the world purifies the water for New York City. This practice has been primarily responsible for the reduction in the typhoid rate in cities, while in the country where the practice is not used, the rate has increased. Another important use for the war gas, chlorine, is for the sterilization and disinfection of city sewage, before it is dumped into rivers, lakes or bays. Contagion from infectious diseases is diminished in this manner. Tanneries are using chlorine or chlorine water to kill the anthrax germ, which is found in raw hides, and which is so fatal to human beings. The bristles for shaving brushes are treated in the same manner. The water in swimming pools can be effectively sterilized by the addition of a little of the gas to the water.

Recently another important use for chlorine has developed. It has been used with commercial success for the manufacture of fine writing papers from low grade raw materials. An Italian manufacturer has developed the process. Such materials, as straw, wood, esparto grass and other low grade raw paper products which have hitherto been used only for making very cheap papers and paperboard, can be treated with chlorine gas and manufactured into a fine, white, high grade writing and printing paper, at moderate cost.

Another gas that was used largely in the war was ethylene. This is now used in the place of acetylene for welding metal. Acetylene burns with a very hot flame in admixture with oxygen in the oxy-acetylene blowpipe. This flame will cut through the thickest piece of steel as if it were butter. Ethylene will do the same work, but it possesses the additional advantage in that when it is used a solvent is dispensed with. Such a solvent must be used with acetylene.

Phosgene is also known as a war gas. It is very poisonous. To-day, a fine perfume, resembling the scent of violets, is made from the gas. Benzyl acetate, another virulent war gar, can be converted by suitable chemical methods into artificial jasmine perfume, more fragrant than the jasmine flower itself. Mustard gas, the gas that causes the eyes to smart and water, is now used in making vulcanized rubber.

At the New York Inventors' Show

(*Continued from page 23*)

alarm goes off warning the house wife that the drip-pan should be emptied. The device is adjustable to bath tubs also, and is driven by a spring under tension.

A person can neither commit suicide nor be asphyxiated if he installs the safety gas jet shown in Fig. 17. Should the gas be

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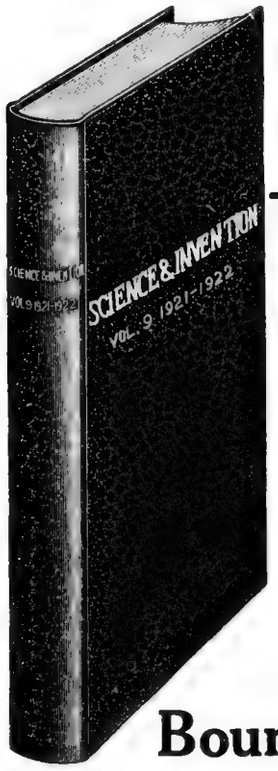

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blown out accidentally, the pilot light which heats the rod of thermostatic metal, is also necessarily blown out, which causes this metal to contract. In doing so, it releases the valve, shutting off the gas supply.

An eastern manufacturer demonstrated their "Kiddie Movies" in another of the booths at this show, which exhibition was very successful from the standpoint of the kiddies and toy manufacturers. C. S. Corrigan was on hand with his torpedo tops, put-and-take devices and dice boxes, as well as spinning eggs, while a tool company attracted the model-makers with their exhibit of the Triplex, a machine which does lathe work, being equipped with chuck, spring collets, taper-turning, boring and thread-cutting accessories. It can be used for horizontal milling with arbor, horizontal, angular and vertical milling with end mill, or can be used for vertical, angular or horizontal drilling and boring.

There were hundreds of other exhibits, many of which will never find their way to the market, perhaps, and others which seemed to promise immediate success. For the present the reader will have to be content with the descriptions given here.

We are inclined to believe that had some of the inventors exhibiting at the show availed themselves of the opportunity offered by our *Patent Advice* columns and our service, they would not have found it so difficult to attempt to interest capital in their inventions. It was simple to find faults with a great many of the inventions, faults which were almost insurmountable in the particular style of the apparatus. It was also easy to discover the reasons why some of the devices will never appear before the public, except as copies of patents and inventors' models.

A perpetual motion machine was also exhibited at this show. The inventor never took into consideration the fact that extra energy would be required to shift a weight when once its center of gravity had been disturbed. Of course, no working model of this device appeared, only a set of figures which were very incomplete, and several large-sized working drawings which graced the walls. We would suggest that our readers refer to our advice given to the inventors so that they, too, shall not try to develop worthless articles.

Gold Medal Awards to Exhibitors at Inventor's Show.

Prof. Wm. A. Beck, Dayton University, Dayton, Ohio.
Stephen Horvath, Cleveland, Ohio.
Triplex Machine Co., New York City.
Wm. J. Luce, New York City.
Hill Rotors, Inc., New York City.
The National Refrigolier Co., Greenville, Ohio.
Albert Pecorella, Buffalo, N. Y.
Frattola, Castelli, Regnoni, Rome, Italy.
Federal Storage Battery Co., Washington, D. C.
Chas. Stanzel, New York City.
Tas-Te Fruit & Canning Co., Paterson, N. J.
Chas. Erickson, New York City.
J. M. Campbell, Brady, Texas.
H. W. De Senitha, New York City.
Science & Invention (Experimenter Publishing Co.), New York City.
Claudio Garcia Huelves, Spain.

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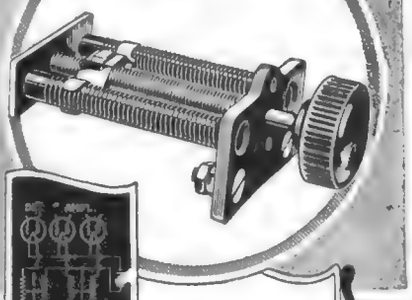

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Measuring the Heat From the Planets

By DONALD H. MENZEL, M.A.

(*Continued from page* 12)

as somewhere between twenty-three hours and two hundred and twenty-seven days (a safe range of values) resembling the earth in the first case, while in the latter one side only would be exposed to the sun.

It is obvious that a rapidly rotating planet would be much cooler than one eternally facing the blazing sun, so measurements of heat radiation suggest that this rotation question may be settled once and for all. Unfortunately, the observations are very difficult to interpret as the temperature derived is midway between the two calculated values and a repetition of the measurements is needed. Probably some observations of the *dark* part of Venus will decide, for if it does rotate, the night side will be warm and if not it will be very cold.

The moon presents a totally different problem. With no atmosphere or water to mitigate the heat, the temperature rapidly rises until under the blaze of a noon-day sun it is fifteen or twenty degrees above that of boiling water, but during the long lunar night, two weeks in length, the temperature rapidly falls toward the absolute zero. There is no way of measuring how cold it may get; we guess 150° to 200° below zero, perhaps even colder.

Saturn and Jupiter come next and are interesting because these calculations upset all ideas of a red-hot planet, as has been predicted and apparently erroneously observed. It turns out that both of these planets are a little warmer than if the sun's rays were their sole source of heat, but even then their temperatures are some hundred degrees below zero, Saturn being a trifle hotter than the larger planet. This result is not unexpected for it is known that Jupiter is the denser of the two, and not expanded so much by internal heat, which, in spite of the cold surface, may be very considerable within. It does not seem possible that either of these planets possess anything like a solid crust considering the fact that Saturn is so light that it would float on water and Jupiter very little heavier. The face of both planets is perpetually clouded with characteristic bands of a yellow to brown color. Possibly these may be caused by materials such as carbon dioxide snow and other frozen gases which might exist there.

Though no measurements have been made on the two outer planets, Uranus and Neptune, they cannot differ much from the two planets last considered. Mercury, the planet nearest the sun is also neglected. It is supposed to keep one side perpetually toward the sun, and, if this is true, the temperature is higher than five or six hundred degrees C., at which heat many substances, including some metals, are molten, but it is useless to speculate as to conditions there. It will be interesting when someone succeeds in measuring the heat. The entire observations will shortly be extended by further investigation, and although some of these results may be slightly changed, at least they give us some idea of the actual conditions at the surfaces of the many planets that join the earth in a ceaseless whirl about the sun.

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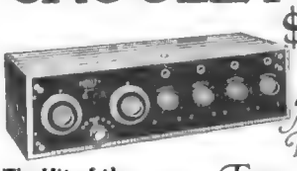

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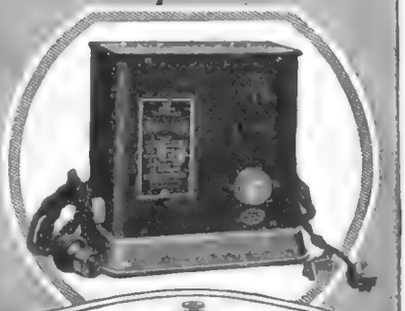

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RADIO CATALOG
FREE TO EVERYONE

Although we would appreciate in stamps to pay printing and mailing.

WEST ELECTRIC CO.
Easten Ave., St. Louis, Mo.

Rubber as Transparent as Glass

By ISMAR GINSBERG.

(*Continued from page 28*)

which would then protect the "glass" and at the same time not reduce its transparency.

Leaving the general field of application for a moment and going over to the scientific field, we find that transparent rubber would be of great value in many ways. For example, it would be of great assistance in the construction of telescopes. It is known that the range of an astronomical telescope is determined by the size of the objective lens, the lens at the end of the telescope, farthest from the eye. Unfortunately, there is a practical limit to the diameter of the lens, when it is made of glass. The cost of the lens and the time consumed in its manufacture and polishing are excessive, and have been the main hinderance in the construction of large telescopes.

If rubber glass can be made in a practical form, it would perhaps offer a solution of this problem. The objective could be made of two pieces of concave "rubber glass", which would be cemented together at the edges. The space between the rubber shell would then be filled with a liquid, possessing the proper index of light-refraction so that a lens or magnifying effect would be obtained. There would undoubtedly be certain difficulties to overcome, but these would probably be less troublesome than those encountered in the construction of a large glass objective.

Transparent rubber would also be of great value to the surgeon. Wrappings of such rubber would permit him to observe the progress of healing of wounds without entailing the need of the removal of bandages. Certain of his instruments could be made of transparent rubber to good advantage. It might also be mentioned that rubber eye-glasses would be a decided advantage, as such glasses would not break when accidentally dropped or thrown off.

Transparent rubber overshoes could be worn without their presence being detected. There would no longer be the embarrassment of wearing rubbers in clear weather. Other articles of wear and adornment could be made of this product. For example rubber bathing caps would allow the color of the tresses underneath to be observed. They would be popular with the ladies.

In the manufacture of toys and novelties transparent rubber would be welcome. Dolls, which can be looked through, balls that appear as bubbles, etc.

In reality the number of applications to which transparent rubber, once it is developed to a commercial stage, can be put is very great. Both in the scientific and general fields, it would be welcomed enthusiastically. Wherever it is desirous to have a solid, non-brittle transparent shell, allowing what exists underneath to appear, in such places this product will find application.

While it is still perhaps merely a scientific speculation—although work has been done in the attempt to perfect its manufacture— it must not be rejected with complete incredulity. There is nothing entirely impossible and the least expected happens very often. Therefore, while realizing the uncertainty that surrounds rubber "glass," we still do not refuse it our attention and await further developments to determine its practicability.

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Protect yourself, your set and your home from this menace with a Lightning Arrester. Every outside aerial attracts lightning. Be prepared when the storms come. Equip your antenna with a protective Arrester approved by the Underwriters' Laboratories. Take no chances with a lightning discharge.

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The reputation of this house was built upon service. Ask any of your radio acquaintances what they think of "RASCO" service, "RASCO" promptness. Thousands upon thousands of unsolicited testimonials are in our files, to prove that we serve the public as it has never been served in radio merchandise before. Be sure to get our great 68-page catalog, containing over 500 different parts. Catalog contains over 300 illustrations.

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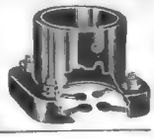
The best Radio Frequency Transformer developed so far. Designed for us by Mr. R. E. Lacault, Associate Editor of RADIO NEWS. For wavelengths of 320 to 420 meters. Air core. Guaranteed to do the work. This Transformer brings in the long distances.

R-2800 Radio Frequency Transformer, size 1⅞"x2¼" $2.00

VACUUM TUBE SOCKET



Made entirely of composition. Gives no rise to capacity effects, as metal sockets do. Positive contacts.

R-6500, Vacuum Tube Socket .....$.35

ANTENNA CONNECTOR

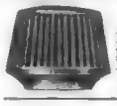
Made entirely of aluminum. Will not rust. The four wires go to upper holes. Lower hole takes lead-in. Don't solder your aerial. Dimensions, 2" high, 1¾" wide.

R-999, Antenna Connector $.30

MOULDED DIALS

Highest grade made. Brilliant black composition. Figures inlaid in white enamel. For ¼" or 3/16" shaft.

R-3074, Dial, 2½" .....$.55
R-3075, Dial, 3½" ..... .65
R-3076, Dial 3⅞" ..... .80



FLUTED KNOBS

Made of best black composition, provided with 8/32" bushing. Height 1", Diameter 1¼".

R-2055 Fluted Knob .....$.15

"RASCO" POSTS

R-650, Post made entirely of best black composition—8/32" screw—each .....$.08

R-202, Post has nickel-plated bottom part, each ..... .08
Dozen, each style ..... .90

650 202

RASCO SWITCH POINTS

Nickel-plated and polished. The following have been found the most popular.

1. ¼"x¼", 6/32" thread, doz.....$.35
2. 3/16" high, ¼" dia., 6/32" thread, doz. ..... .35
3. 3/16"x3/16", 4-36 thread, doz. .35
4. ¼" dia., ⅛" thick; shank 6/32" doz. ..... .40
5. ¼" dia., 3/16" thick; shank 4-36, doz. .40
6. 3/16" dia., 3/16" thick; shank 4-36, doz. .40
7. 3/16" dia., ⅛" thick; shank 4-36, doz. .40
75. Switch Stop ⅜" long, 4-36 thread, complete with nut, each ..... .04
76. New style Switch Point, to be pressed into bakelite panels with forced fit. Wire is soldered to pin end. Head ¼" dia., 1/16" thick, doz. ..... .40
77. same as above, but head is ¼" dia. x 3/16" thick, doz. ..... .40

SOCKETTES

Substitute for Vacuum Tube Socket. Four of these take one Vacuum Tube. Grasp tube firmly. Best contact possible. Take less room. Are better.

R-1550, Sockettes, nickeled, set of 4 .....$.25

R-1551 Sockettes, nickeled, set of 4 (to take WD-11 Tube) ..... .25

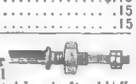
Note: Set of 4 sufficient to hold 1 Tube.

VACUUM TUBE FUSES

Insure your tubes against blow outs.

R-2575, Fuse, 1 ampere.....$.15
R-2576, Fuse, 1½ ampere ..... .15
R-2577, Fuse, 2 ampere ..... .15

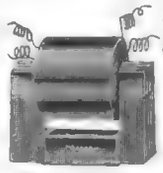
UNIVERSAL BEARING



THE bearing to hold variometer and variocoupler rotors. Total length of bearing 2¼". Outside shaft, 1¼". Length of thread 1". Length of threaded sleeve, ¾".

R-1375, Bearing .....$.25

AUDIO FREQUENCY TRANSFORMERS



No better Transformer on the market. Highest class materials. Impregnated coils. Silicon steel stampings used. Save 50 per cent by assembling it yourself.

R-1100, A.F. Transformer, ratio 4½ to 1 .....$2.65

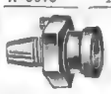
R-1150, A.F. Transformer, ratio 6½ to 1 ..... 2.65

HONEYCOMB COILS

No better coils on the market. Too well known for lengthy description. Firm impregnation. Range given is in meters when varied with a .001 Variable Condenser:

No.	Turns	Range	Price
R-5000	25	120- 250	$ .40
R-5001	35	175- 450	.45
R-5002	50	240- 720	.50
R-5003	75	390- 910	.55
R-5004	100	500- 1450	.60
R-5005	150	600- 2000	.65
R-5006	200	900- 2500	.75
R-5007	250	1200- 3500	.80
R-5008	300	1500- 4500	.85
R-5009	400	2000- 5000	1.00
R-5010	500	2800- 6100	1.15
R-5011	600	4000-10000	1.30
R-5012	750	5000-12000	1.45
R-5013	1000	7900-15000	1.70
R-5014	1250	9750-19500	1.95
R-5015	1500	14500-26500	2.20

CORD TIP JACKS



Take the place of binding posts on instruments or panel. Cord tip firmly gripped by jack. Made of brass, highly nickel-plated and polished. Screw to attach lead wire. No soldering necessary.

R-1500, Cord Tip Jack, each.....$.15

CARDBOARD TUBING

Only seamless tubing made in United States. Perfectly seasoned. Heavy wall. (I.D.—Inside Diameter. O.D.—Outside Diameter. L.—Length).

R-6600, 3" I.D., 3¼" O.D. x 7" L. .....$.30
R-6601, 3½" I.D., 3¾" O.D. x 7" L..... .35
R-6602, 3¾" I.D., 3¾" O.D. x 5" L..... .25
R-6603, 3¾" I.D., 4" O.D. x 5" L..... .27
R-6604, 4" I.D., 4¼" O.D. x 5" L..... .35
R-6605, 2¾" I.D. 3" O.D. x 2⅜" L..... .15

MICANITE TUBING

Especially suitable for CW work Nothing better made. Natural color.

R-250, Micanite Tubing, 4" dia., 6" long $1.20
R-251, Micanite Tubing, 6" dia., 6" long 1.60

JACKS AND PLUGS

Best material. Only pure silver contacts used. Factory that makes Postal Telegraph jacks makes these. This is your guarantee.

R-1000, Jack, 4-springs double circuit .....$ .75
R-1001, Jack, 3-springs .80
R-1002, Automatic 5-spring Jack..... 1.00
R-1003, Plug ..... .65

BUS BAR WIRE

This wire is square, measuring 1/16" by 1/16". Easy to solder as it is already tinned. Used on all up-to-date instruments. Sold in 2-foot lengths only.

R-6400 Bus Bar Wire, per 2-foot length..$.05

NON-INDUCTIVE RESISTANCE

Made of special graphite copper-plated at the ends. Round rods 1¾" long, ¼" diameter. Resistance accurate within 20 per cent.

R-5300 Resistance 12,000 ohms.....$.65
R-5301, Resistance 70,000 ohms..... .65

BRASS RODS

Sold in 6" lengths only

R-8032, Brass Rod, 8/32" thread, per length .....$.08
R-6032, Brass Rod, 6/32" thread, per length ..... .06
R-1425, Brass Rod, plain ¼" round, per length ..... .10
R-3616 Brass Rod, plain 3/16" round, per length ..... .06

"RASCO" BABY DETECTOR

Base is solid black composition; mounted on same is nickel holder and binding post, which holds the fluted hard rubber knob with its sliding rod member. Patent nickel detector cup and binding post. Patent cup holds crystal.

R-1898, Baby Detector, with Galena .....$.50

"RASCO" LUBRICATED PANEL SWITCH

Our patent spring fork holds the switch handle always at a uniform tension. At the same time it insures best contact possible. New wiping contact covers every portion of the switch point. Double leaf blades used.

R-1921, "Rasco" Switch .....$.40

PANEL SWITCH LEVER

Impossible for this lever not to make positive contact. Leg radius 1¼". Nickel-plated and polished. Lock fork holds the screw (in which it rotates) securely. Loose contact impossible.

R-200, Switch Lever .....$.30

"RASCO" NAME PLATES

The circular plate is our new Binding Post Name Plate. Diameter, ⅞". These denominations: PHONES, GROUND, —, OUTPUT, "A" BATTERY —, "B" BATTERY—, LOUD SPEAKER, GRID, LOAD, "C" BATTERY—, AERIAL, +, INPUT, "A" BATTERY+ "B" BATTERY +, LOOP, TICKLER, PLATE, "C" BATTERY +, FILAMENT.

R-6000 to 6019, Binding Post Name Plates, each denomination .....$.03
Dozen ..... .30

Square Name Plates

Same denominations as above also these: SERIES 1st STEP, 2nd STEP, 3rd STEP, SECONDARY CONDENSER, TELEPHONE, SECONDARY, DETECTOR, TRANSMIT, GRID VARIOMETER, PARALLEL, COUPLING, PRIMARY, LOADING COIL, RECEIVE, ANTENNA, PLATE VARIOMTER, "BLANK", AUDION, ON, OFF.

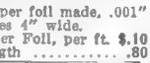
R-834 to 866, Square Name Plates, each..$.04
Dozen ..... .40
R-839 "INCREASE CURRENT" (Right)
R-840 "INCREASE CURRENT" (Left)
Each ..... .10

VERNIER

Cleverest vernier made. Can be used with any dial. Soft rubber ring engages dial. Does away with vernier condenser. We guarantee results. All metal parts moulded in best black composition. Nothing to come apart. Biggest hit of the season.

R-1450, Vernier .....$.30

"RASCO" CONDENSERS



R-5050, Phone Condensers, each.....$.20
R-5056, Grid Condensers, each..... .20
R-5059, Grid Leak Condensers, each ..... .30

COPPER FOIL

Thinnest copper foil made, .001" thick. Comes 4" wide.

R-5025, Coper Foil, per ft. $.10
10-ft. length ..... .80

RADIO CEMENT

Weather resisting. Used particularly for cementing covered wires. Coils covered with this cement require no form. Wires hold together solely with this cement.

R-1750, Cement, 2-oz. bottle $.50

TELEPHONE SHELL AND CAP

For the experimenter we list this composition shell and cap. No holes in shell whatsoever. Takes standard 2½" diaphragm.

R-2700, Shell-and-Cap, complete .....$.65
R-2701, Shell only ..... .40

MICA DIAPHRAGMS

Made of special India mica in two sizes, 2½" diameter and 1-13/16" diameter. Excellent for experimentation in telephone work.

R-2550, Diaphragm, 2½" .....$.20
R-2551, Diaphragm, 1-13/16" ..... .15

RHEOSTAT WINDINGS

These windings, with the switch arm shown below, constitute a complete rheostat for the experimenter. Resistance wound on flexible black fibre. Carries 1½ amperes, resistance 6 ohms.

R-4300, Rheostat Resistance each .....$.20
R-4301, Potentiometer Resistance, each (200 ohms) .. .35

Fits above.

R-1675, each .....$.10

MAGNET WIRE

We list only best qualities. "DCC" means Double Cotton Covered. "GS" means Green Silk. "E" stands for Enameled. The following come on 8-ounce spools:

R-2500, DCC No. 18.....$ .50
R-2501, DCC No. 20..... .60
R-2502, DCC No. 22..... .75
R-2503, DCC No. 24..... .85
R-2504, DCC No. 26..... .95
R-2505, DCC No. 28..... 1.15
R-2506, DCC No. 30..... 1.65

The following come on 4-ounce spools:

R-2507, GS No. 20.....$ .50
R-2508, GS No. 22..... .55
R-2509, GS No. 24..... .60
R-2510, GS No. 26..... .65
R-2511 GS No. 30..... 1.05
R-2512, GS No. 32..... 1.30
R-2513 GS No. 36..... 1.85

The following come on 8-ounce spools:

R-2514, E No. 20.....$ .45
R-2515, E No. 22..... .55
R-2516, E No. 24..... .60
R-2517, E No. 26..... .65
R-2518, E No. 30..... .70
R-2519, E No. 32..... .80
R-2520, E No. 36..... 1.00

LITZ WIRE

R-323, equals No. 25 B&S, per foot .....$.02
R-890, equals No. 28 B&S, per foot ..... .01
R-891, equals No. 21 B&S, per foot ..... .03
R-892, equals No. 20 B&S per foot ..... .04
R-893, equals No. 14 B&S, per foot ..... .12

Discounts of 10 per cent in 100-foot lots.

The "Rasco" Catalog

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500 ARTICLES, 68 PAGES

All Armstrong Circuits: These important circuits are explained clearly, all values having been given leaving out nothing that could puzzle you.

Just to name a few of the Vacuum Tube circuits: The V.T. as a detector and one-step amplifier; Armstrong circuits; one-step radio frequency amplifier and detector; three stage audio frequency amplifier; short wave regenerative circuits; 4-stage radio frequency amplifiers; radio and audio frequency amplifier; inductively coupled amplifier; Armstrong superautodyne; radio frequency amplifier and crystal detector; combination V.T. detector one stage amplifier; two stage radio frequency amplifier and detector with feedback coupling (regenerative); regenerative receiver, using single spider web coil; Armstrong super-regenerative circuit; two stage radio frequency amplifier coupled to a two-circuit tuner, using two-slide tuner regenerative receiver; two stage audio-frequency amplifier, using crystal or V.T.; one stage radio frequency detector, two stages audio-frequency with feed-back coupling to first tube; power amplifier with loud speaker; regenerative receiver and one stage amplifier for DX work; one stage radio frequency detector with feed-back coupling; three stages radio frequency, two stages audio-frequency loop reception; crystal detector with rectification; one tube super-regenerative receiver; short wave regenerative receiver with two variocouplers, capacity-coupled tuner; trap circuit to eliminate interference; selective circuit to eliminate interference The catalog contains 300 illustrations. On account of its great cost, it cannot be distributed free of charge Mailed only upon receipt of

15 Cents in Stamps or Coin.

This business was originated with the sole idea in mind to cater to the radio amateur who has small orders. ALL OF OUR ORDERS ARE SMALL. THAT IS WHY YOUR SMALL ORDER CAN NEVER BE SIDE-TRACKED BY US. A trial order will make you a life customer. Order from the above illustrations. 24-hour service guaranteed. "WE CAN ONLY DISAPPOINT YOU ONCE." Try us with a 50c. order and make us prove what we say. Prices include delivery to your door.

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Factories: Brooklyn, N. Y. — Elkridge, Md.

DEALERS

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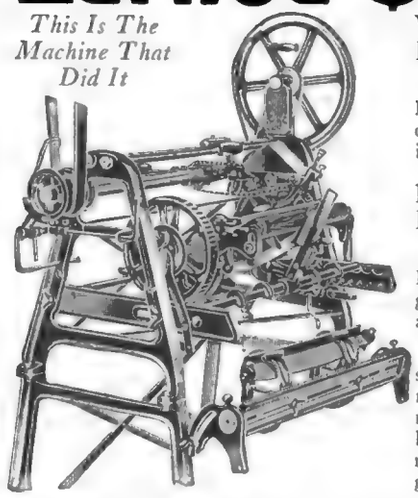
My Ideal Lawnmower Grinder

Earned $1662.19 IN 1922

This Is The Machine That Did It



W. F. KENDT, of 1476 Main Street, Buffalo, writes:

"I sharpened 994 lawnmowers on my Ideal Lawnmower Grinder during the grass season of 1922, and the receipts were $1662.19, which is not bad for a side line."

E. W. MCCORMICK, of Saginaw, Mich., writes:

"Five years ago I purchased from you an Ideal Lawnmower Grinder with which I ground over 5000 mowers. If I could not buy another I would not take $1000 for it."

Put an Ideal Lawnmower Grinder in your shop. It sharpens a Lawnmower keen as a razor every 20 minutes without removing reel knives. Mowers run easily—owners delighted—they tell others—you are in big demand. Costs but little and will prove the greatest money maker you ever installed.

Write today for booklet "Let George Say It," and catalog. Buy early and start with the first grass clip.

THE FATE-ROOT-HEATH CO., High & Bell Sts., PLYMOUTH, OHIO

75c

SINCE selling our "Rico" Loud Speaker 'Phone we have had a tremendous demand for an adapter by which a 'Phone can be adapted to any phonograph.

Our new **Phonodapter** is the result of this demand. The "RICO" Phonodapter presents many unique advantages over other similar adapters. In the first place, the entire adapter is made of pure rubber and will stretch over any make of 'phone. It has, however, been especially developed for the "RICO" Loud Speaker 'Phone. This adapter does not give rise to echoes, as is the case with most of the others that we have examined. There are no echo air chambers left after the adapter is attached to the 'phone, as is the case with so many others.

Study the illustration carefully and become convinced why ours **must** be better than most others. The illustration also shows the brass tube inserted in the smaller part of the **Phonodapter**. With this brass tube the **Phonodapter** fits all Columbia phonographs. By removing this tube, the **Phonodapter** fits Victor, as well as Sonora phonographs. It will be seen, for this reason, that the **Phonodapter** is a universal article, which must appeal instantly to every one.

OTHER USES

The above, however, does not exhaust the uses of the "RICO" **Phonodapter**, because it can be used in connection with standard horns. It is realized that it is almost impossible to fit the "RICO" Loud Speaker 'Phone, or, for that matter, any receiver, to a horn, if you should happen to have such, without an adapter. The "RICO" **Phonodapter** can be used to couple any 'phone to a horn, if you have a spare horn lying about. Or if you know where you can obtain one, the **Phonodapter**, will solve your difficulty. If you do not wish to go to the expense of a horn, and wish to improvise one it can be easily made by rolling and pasting together a sheet of stiff Bristol Board and fashioning it into a horn. If the lower extremity is fitted over the brass tube of the "RICO" **Phonodapter** you will at once have a horn which in an emergency will prove quite satisfactory. Such horns can be made as large as desired. We guarantee the **Phonodapter** to do all that we say, and shall cheerfully refund the purchase price if it is not found satisfactory in all respects.

No. 131 "RICO" Phonodapter, as described, each, prepaid.....$ .75

THE "RICO" LOUD SPEAKER 'PHONE. The **Rico Loud Speaker 'Phone** has a heavy aluminum shell, hard rubber composition cap, non-rusting sherardized diaphragm. It is furnished complete with a 5-foot cord, ready to attach to your horn.

SPECIAL OFFER

We are so convinced that every user will be enthusiastic about this 'phone that we have made a special offer of 5 days' trial, whereby we shall take back and refund the money for any **Rico Loud Speaker 'Phone** at the end of 5 days, if it does not prove entirely satisfactory.

Send No Money. Don't send us a penny now. Just write and tell us you want this wonderful 'phone and we will rush the order to you at once. Pay your postman the price of the 'phone and then test it at our expense..... **$4.50**

Send for our free illustrated circular listing all our other types.

RADIO INDUSTRIES CORPORATION
131 Duane St., New York

Our Genuine Skinderviken Transmitter Button

Actual Size

Thousands in use for Wireless, Loud Speakers Amplifying and all sound transmission purposes.

Price $1.00

POSTPAID with instructions

Free Literature

K. ELECTRIC CO.

15 PARK ROW NEW

RUSONITE

CRYSTAL RECTIFIER

MULTIPOINT

(Patent Pending)

A Synthetic CRYSTAL DETECTOR, sensitive over its entire surface.

Eliminates all detector troubles. Extraordinary clearness and volume. Endorsed by Radio experts and press. Sold in Sealed Packages only. Join the ever increasing Rusonite fans.

Price, Postpaid, mounted. 25c.

Sensitiveness guaranteed ...

RUSONITE CATWHISKER

14 Karat Gold Multipoint Contact 50c.

sensitive .....

Order from your dealer or direct from us.

RUSONITE PRODUCTS CORP.

W. N. Y. Dept. "S"

Treating Cancer with X-Rays

(*Continued from page* 11)

there is a certain air distance between the focal point in the X-ray tube and the body of the patient which varies from two to three feet, to which an additional distance, which may be as much as five inches must be added as the distance from the skin to the tumor.

X-rays should not be used alone as a rule for the treatment of cancer patients. On the other hand, when used in conjunction with surgical procedures and radium, they give results in cancer therapy today which are much more gratifying than the results obtained a generation ago.

Dr. Isaac Levin draws the following conclusion. "Cancer therapy requires a great deal of sound judgment and influence in handling complex chemical conditions. The cooperation and real team work of physicists, chemists, biologists, and clinicians of all special tests in medicine are essential in order to obtain good results in treatment of cancer patients."—*Staff Photos Courtesy Montefiore Hospital.*

Transplanting Insect Heads

By RUDOLPH ADOLPH.

(*Continued from page* 28)

The insects with transplanted heads are kept in a damp compartment for two or three weeks. This is approximately the time required for co-ordinated movements to re-establish themselves. During the first week the wound between head and thorax closes over. The complete capability of action is only restored to the head after one or two months.

Now Dr. Finkler made an exchange of heads between male and female water beetles, to test the reaction of the sexes between beetles so operated on.

The heads were exchanged between male and female beetles who had been kept separate for some time, and after perfect healing had taken place, the male and female species were put in the same compartment filled with water, two by two, and their actions were observed The female beetles with heads of males acted as if they were of the same sex as their heads. The normal male beetle distinguished no difference in them. The male beetles with female heads were perfectly passive.

Now Finkler exchanged heads between males and females of water beetles, to test the sex-instinct reaction between insects thus operated on. "The normal male of the water beetle" writes Finkler, "prepares for copulation with the front pair of legs upon the thorax of the female, while the rearmost pair of legs holds fast the steering-feet of the female and the middle pair is free and serves for slow movements. The female remains passive."

The heads were exchanged between male and female beetles, which had hitherto been kept separated. After complete healing the insects, in the different sex combinations, were placed in couples in a vessel with water, and were subjected to further observation.

The females with male heads went through the above described preparations for copulation and acted as if they were males, and yet would only cover females. They were treated by normal males as if the latter were dealing with females.

Males with female heads acted quite passively towards both sexes as if they were normal females.

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This is the *original* Transmitter Button, U. S. Pat. No. 1439117

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The Best Transmitter Button

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WHAT IT IS

The N-S Microphone Button is a miniature telephone transmitter. The button is composed of four essential parts, as follows:

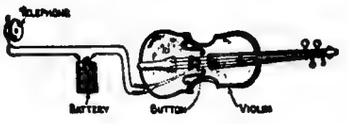
Full Size

1. A brass cup or rear electrode.
2. A mica disc.
3. A brass button or front electrode.
4. Carbon granules.

The front electrode is held in place by the mica disc and the space between the front and rear electrodes is filled with the carbon granules. The mica disc acts as a cover to the cup shaped rear electrode and is clamped in place by a threaded brass ring. This efficient and practical device is known as the

N-S Microphone Button

How to Use the N-S Button

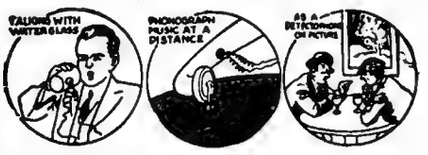


You can easily make a highly sensitive detectophone using an N-S Transmitter Button to collect the sound waves. You can build your own Outfit without buying expensive equipment. Think of the fun you would have with such an instrument! It's very simple, too, and inexpensive.

You can install an outfit in your home and hear the conversation being held all over the house. You can connect up different rooms of a hotel. *This type of outfit was used by secret service operatives during the War. It is being used on the stage.*

So much for its commercial adaptations!

One of the main advantages of the N-S Transmitter Button lies in its ultra-sensitiveness. You can place it in any position you like. It is the greatest invention in microphones and has won recommendations from men of high standing in the scientific world. It is being used all over the world. You can mount it most anywhere. Card board boxes, stove pipes, stiff calendars and hundreds of other places will suggest themselves to you. The buttons can not be seen by any one in the room as they are so small and light. Only a small brass nut is exposed to the view.



The only instruments needed to complete a detectophone outfit, in addition to an N-S Transmitter Button are a receiver, battery, and, if desired, an induction coil.

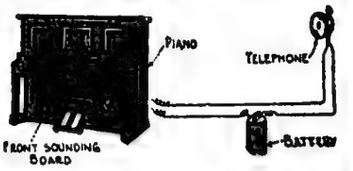
Renewing Old Telephone Transmitters

The N-S Microphone Button may be used to renew telephone transmitters on farmer lines, intercommunicating systems, etc.

The N-S Button is ideal for this purpose and will often make an old line "talk up" when nothing else will. The N-S Button makes a more efficient sound reproducer than most of the transmitters in use today.

For Radio Telephone Transmission

The N-S Microphone Button makes the ideal modulation microphone for radio telephone use. It will carry heavy current and is extremely sensitive. If larger power tubes are being used, several N-S Buttons may be attached to a single diaphragm and connected in parallel, thus dividing the current and preventing packing. Furthermore, when the carbon granules are finally pitted, or abused by packing, they may be instantly replaced at small charge. Excellent diaphragms may be made of tin or brass sheet and experimenting with various types and sizes of diaphragms will prove most interesting and profitable.



Loud Speakers and Amplifiers

Many different methods are available to the users of N-S Microphone Buttons for amplifying radio signals. The button may be attached to the diaphragm of the telephone receiver, a local battery and 80 ohm receiver being connected in series. Various types of lever action may be experimented with. The field is most interesting and may lead to some ingeneous discoveries in the line of loud speakers.

Experimenters

will find th N-S Microphone Button a source of countless experiments along the lines of telephones, amplifiers, loud speakers, etc. Many fascinating *stunts* may be devised, such as holding the button against the throat or chest to reproduce speech without sound waves, etc.

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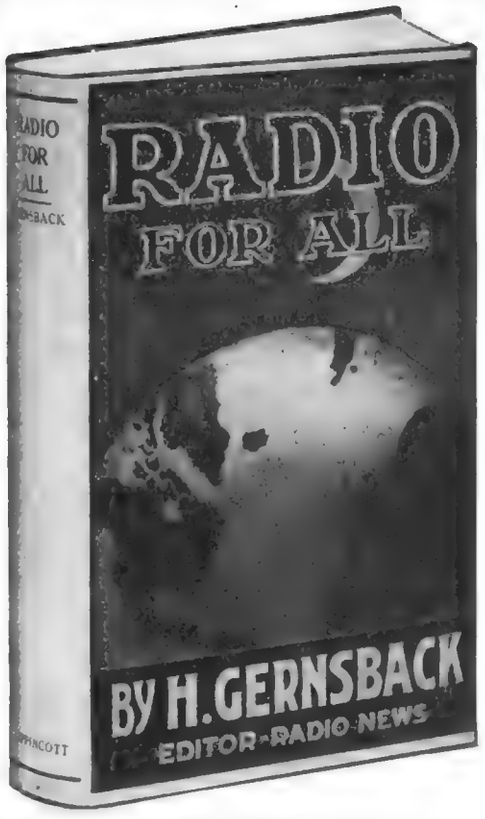

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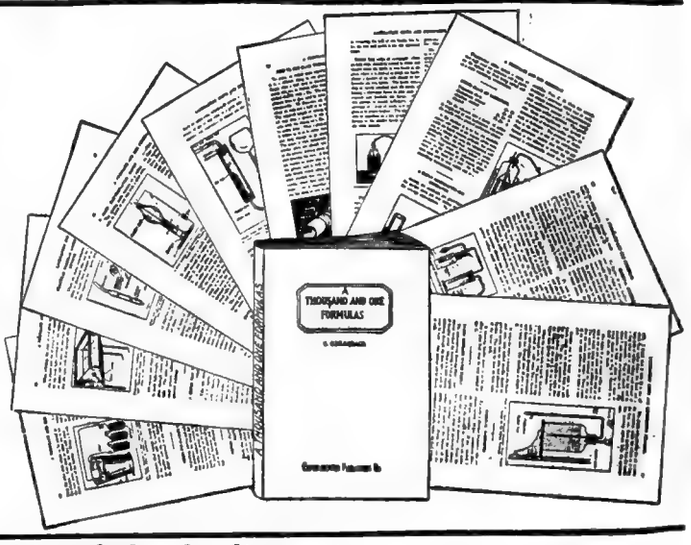

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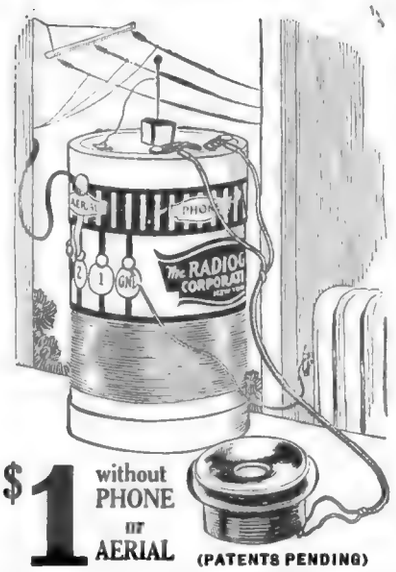

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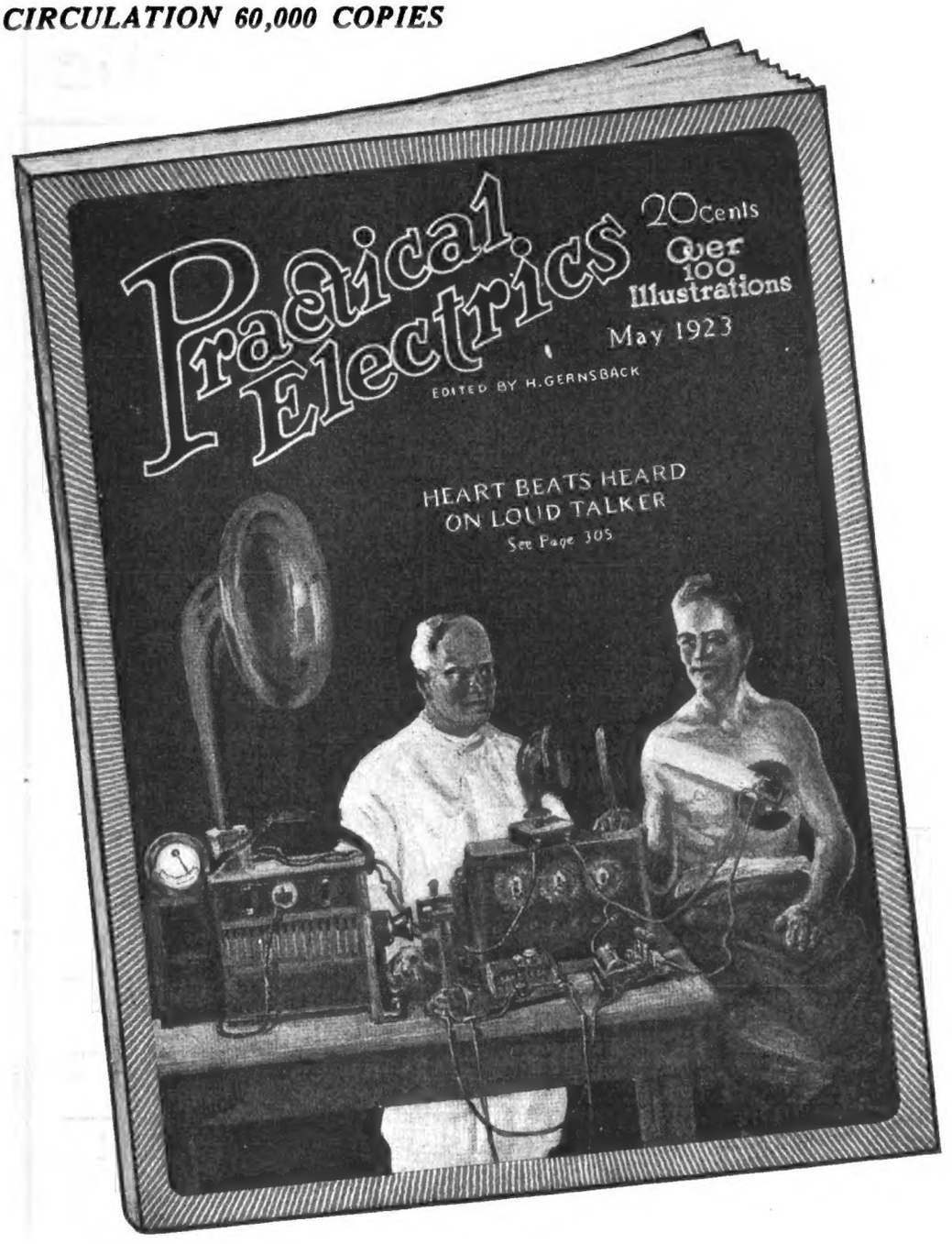

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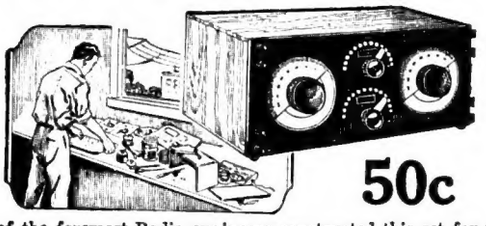

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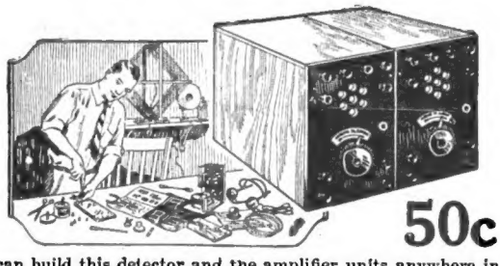

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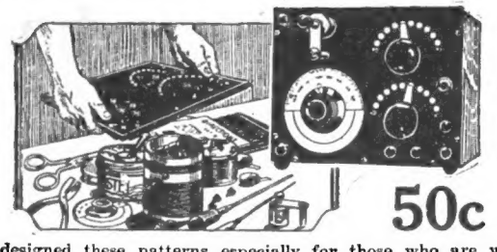

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